ENDANGERED SPECIES ACT - SECTION 7

BIOLOGICAL OPINION

UNLISTED SPECIES ANALYSIS, AND SECTION 10 FINDINGS;

and

MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT CONSULTATION

for Proposed Issuance of a Section 10 Incidental Take Permit for the Tacoma Water Habitat Conservation Plan, Green River Water Supply Operations and Watershed Protection, King county, Washington

WSB 00-522

Agency: National Marine Fisheries Service

Consultation
Conducted By: ` National Marine Fisheries Service
Northwest Region
Washington State Branch Office

Approved ____________________ Date 7/9/2001
Donna Darm
Acting Regional Administrator

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I. BACKGROUND

This document constitutes the National Marine Fisheries Service (NMFS) Biological Opinion (Opinion), Unlisted Species Analysis, and Findings prepared pursuant to section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.) (Act). This document describes the potential effects of issuing a proposed incidental take permit to the City of Tacoma Water Division (Tacoma Water) , an agency of the City of Tacoma, Washington, for up to 6 species of listed and unlisted Pacific salmon for a period of 50 years, pursuant to section 10(a)(1)(B) of the Act. This Opinion is based on the NMFS and United States Fish and Wildlife Service (USFWS, together the Services) separate and collaborative reviews of the conservation, minimization, and mitigation measures proposed in the Tacoma Water Multi-Species Habitat Conservation Plan (final HCP, Tacoma 2001) and Implementing Agreement (IA), for the Green River and the Upper Green River Watershed in King County, Washington.

The proposed incidental take of up to 32 listed and unlisted species (the total number of HCP-covered species) would occur through a suite of activities consistent with the final HCP and IA (Tacoma 2001). By general category, these activities are associated with: 1) the withdrawal of water under the First Diversion Water Right Claim (FDWRC), the Second Diversion Water Right (SDWR), and effects of springtime storage of the SDWR on downstream resources in the Green River, and 2) the management of the upper Green River watershed above the Tacoma Headworks diversion at River Mile (RM) 61.0. These activities are interrelated, but they are not interdependent. The water withdrawal facilities could be operated with or without incidental take coverage for the upper watershed, and management of the upper watershed could continue regardless of the manner in which water is withdrawn. These two categories of activity are comprised of component activities (detailed in subsection 2.6 of the final HCP) that include: 1) water withdrawal at Tacoma's Headworks (associated with FDWRC and SDWR); 2) water withdrawal from the North Fork well field; 3), construction of Headworks improvements; 4) operation of the downstream fish bypass facility at the Headworks; 5) Tacoma watershed forest management based on the Green River Watershed Forest Land Management Plan (Ryan 1996); 6) monitoring of downstream fish passage through the Howard Hanson Dam (HHD) Reservoir and fish passage facility; 7) monitoring and maintenance of fish habitat restoration and fish and wildlife mitigation projects pursuant to a separate Additional Water Supply project (AWS) being undertaken by the U.S. Army Corps of Engineers; 8) potential restoration of anadromous fish above HHD, and; 9) all other mitigation measures described in Chapter 5 of the final HCP. Note that the USFWS is preparing a companion Biological Opinion/Conference Opinion on the subject section 10 permit application for coverage of 28 aquatic and terrestrial species under its purview (USFWS May 2001), and will be evaluating a separate incidental take permit application from the City of Tacoma.

A portion of the water to be withdrawn from the Green River by Tacoma will be made available through the AWS, which is a modification to the operation of HHD by the U.S. Army Corps of Engineers (USACE). The USACE will store additional water behind HHD in the spring, and release the water in the summer and fall. Some of the additional stored water will be used to benefit fish by augmenting low flows in the Green river, but most will be withdrawn by Tacoma Water to meet municipal water supply needs.

While Tacoma Water is the local sponsor for the AWS, the USACE will be the lead federal agency responsible for the AWS. The NMFS has formally consulted with USACE under Section 7 of the Act and issued a Biological Opinion that determined, based on the available information, that the USACE operation and maintenance of HHD and development and implementation of the AWS project is not likely to jeopardize the continued existence of the threatened Puget Sound chinook salmon Evolutionarily Significant Unit (ESU) (*Oncorhynchus tshawytscha*) or result in the destruction or adverse modification of critical habitat (NMFS Section 7 Biological Opinion, WSB-00-198, on file at the NMFS WSHB office, Lacey, WA). That Opinion concluded that the collection of conservation measures, specifically the fish passage facilities and their operation, reverses the adverse modification of critical habitat by restoring anadromous fish access to the upper river basin. The USACE action analyzed in that Opinion also includes a framework for a proposed sediment management plan to be developed by the Corps in the first two years after completion of that formal consultation (approximately October 2002). The framework for development of this sediment plan proposes measurable targets for sediment routing through the reservoir at the HHD project.

While the operation of the HHD and implementation of the AWS project is a separate federal action with incidental take covered under a separate consultation (referenced above), the conduct of these activities and their effects are considered part of the baseline environmental condition and considered in this analysis to the extent that Tacoma may incur liability or responsibility for take of listed (or future listed) species or their habitats. This take may occur with Tacoma's involvement through sponsorship or interrelated activities of the USACE in the conduct and implementation of activities specifically covered under Tacoma's Habitat Conservation Plan (HCP, Tacoma December 2000). The USACE activities associated with the AWS project are listed in Table 2-2 of the HCP and summarized in this Opinion.

Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to, and not intended as part of, the agency action is not considered prohibited taking provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The measures described below are non-discretionary; they must be implemented by the action agency so that they become binding conditions of any grant or permit issued to the applicant, as appropriate, in order for the exemption in section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered in this incidental take statement.

Tacoma Water relies on the AWS project to exercise a portion of its Second Diversion Water Right on the Green River in the late summer and early fall, these withdrawals are covered for incidental take of threatened Puget Sound chinook under a separate consultation between NMFS and the USACE (Biological Opinion for the Howard Hanson Dam Operation, Maintenance, and Additional Water Supply Project; October 2000; WSB-00-198, on file at NMFS WSHB office, Lacey, WA). Mitigation measures include construction and operation of downstream passage facilities, and implementation of certain fish and wildlife habitat restoration activities. This interdependence between Tacoma and the USACE provides that the environmental effects of all activities are addressed, and incidental take coverage is secured for any and all anticipated take of federally listed species, as part of AWS implementation.

This Opinion considers the potential effects and incidental take of the proposed action on the threatened Puget Sound chinook salmon Evolutionarily Significant Unit (ESU) (*Oncorhynchus tshawytscha*). Also considered are candidate status coho salmon (*O. kisutch*) in the Puget Sound/Straight of Georgia ESU. Three unlisted Pacific salmonid ESUs are present in the Plan Area and are addressed in this Opinion: 1) chum salmon - Puget Sound/Strait of Georgia ESU, 2) pink salmon (*O. gorbuscha*) - odd year ESU, and 3) steelhead trout (*O. mykiss*) - Puget Sound ESU. Sockeye salmon (*O. nerka*) are present in Plan Area but are not recognized as a separate ESU (see Gustafson *et al.* 1997). Together, these seven candidate and unlisted species are considered in this Opinion under the Services' No Surprises Policy (63 Fed. Reg. 8859) and fulfilling the Service's commitments specified in the IA (Tacoma 2001) should these ESUs, or future modifications thereof, require protection by listing under the ESA.

NMFS concludes that the proposed action is not likely to jeopardize the subject species, or destroy or adversely modify designated critical habitat. Included in this Opinion is an incidental take statement. This consultation is conducted pursuant to section 7(a)(2) of the ESA and its implementing regulations, 50 CFR 402.

Section IX satisfies the consultation requirements under the Magnuson-Stevens Fishery Conservation and Management Act (MSA), as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267). The act requires the inclusions of Essential Fish Habitat (EFH) descriptions in Federal fishery management plans and requires Federal agencies to consult with NMFS on activities that may adversely affect EFH.

A. Consultation History

From January 1988 to January 2000 the Services provided technical and policy assistance to Tacoma during the development of their Green River Water Supply Operations and Watershed Protection Habitat Conservation Plan. Species lists of endangered, threatened, and proposed species known to occur in the Green River Watershed were prepared and updated by the Services throughout the development of the HCP. The latest of these letter was prepared and signed by the Services on March 30, 1999 (FWS Ref. 1-3-99-SP-0388). Subsequent updates on the status of bull trout and peregrine falcon were provided verbally as these species became listed and delisted, respectively.

Tacoma first submitted a preliminary working draft to the Services in September 1998. In November of 1998, Tacoma submitted the first working draft of the HCP to the Services, as well as, the US Environmental Protection Agency, US Army Corps of Engineers, Muckleshoot Indian Tribe and several Washington State resource agencies. In addition, copies of this draft were placed in six public libraries for citizen review and comment. A second working draft of the HCP was submitted to the Services in July of 1999. This draft was also mailed to other federal, state, and local governmental agencies, and the Muckleshoot Indian Tribe for review and comment prior to the development of the final draft HCP.

During the development of this draft the Services also were working with Tacoma to develop an Environmental Impact Statement (EIS) and Implementing Agreement (IA) to accompany the HCP. The Services formally initiated an environmental review of the project through a Federal Register notice on August 21, 1998 (63 FR 44918). This notice stated that an Environmental Assessment (EA) or an EIS would be prepared. The notice also announced a 30-day public scoping period during which other agencies, tribes, and the public were invited to provide comments and suggestions regarding issues and alternatives to be considered. A second Federal Register notice was published following the scoping period on January 20, 1999 (64 Fed. Reg. 3066), announcing the decision to prepare an Environmental Impact Statement. Tacoma submitted final draft documents of the HCP, EIS, and IA with their formal application for an incidental take permit on December 23, 1999. On January 14, 2000, the Services initiated a 60-day public comment period under the National Environmental Policy Act of 1969, as amended (NEPA)(63 Fed. Reg. 68469). The comment period was extended for 17 days to March 31, 2000 (65 Fed. Reg. 13947), in direct response to requests from the public. This resulted in a total comment period of 77 days.

A total of 73 comment letters were received by the Services pertaining to the DEIS and HCP: 10 from government agencies, 2 from tribal representative organizations, 11 from public organizations, and 50 from individual citizens. Volume II of the FEIS contains copies of all of those letters and the Services' responses. Many of the comments and suggestions were incorporated into the HCP and FEIS. A summary of changes made to the HCP and EIS is included the Preface section of the FEIS.

The Final Environmental Impact Statement was noticed in the Federal Register on January 5, 2001 (66 FR 1089). Two public interest groups and one individual submitted comment letters regarding the FEIS. Summaries and responses to comments are contained in Appendix B of the Services Record of Decision (July 2001, on file at NMFS WSHB office, Lacey, WA).

B. Consultation History - U. S. Army Corps of Engineers

The U. S. Army Corps of Engineers (USACE) previously prepared a draft Biological Assessment (BA) for the AWS in 1998. Informal consultation through inter-agency meetings in 1999 led to the preparation of a Programmatic Biological Assessment (PBA), encompassing operation and maintenance of the existing project without conservation measures, the existing project with conservation measures, the proposed AWS without conservation measures, and the AWS with conservation measures. Uncertain as to how to frame the proposed action and proceed in to consultation with NMFS, the Corps' PBA described several actions and the requested consultation on the resultant multiple effects determinations. This uncertainty was partially the result of the fact that the ongoing operations and maintenance activities at the HHD had not previously been subject to formal consultation under the Endangered Species Act.

The PBA was submitted to NMFS April 5, 2000. NMFS and the USACE met again on May 2, 2000 in an effort to frame the proposed action so that NMFS could consult on a single effects determination. The USACE, by a letter dated May 17, 2000, modified the PBA to describe a single analysis and effect determination for the operation and maintenance of the existing project and proposed AWS with conservation measures. This is the project configuration and proposal analyzed in NMFS Biological Opinion (WSB-00-198, on file at NMFS WSHB office, Lacey, WA) Because the proposed action included, in part, ongoing operations and maintenance, the effects analysis for many of the parameters analyzed was the same as the environmental baseline. The proposed action included a framework for a sediment management plan that would be developed by the Corps in the first two years after completion of this formal consultation. The framework is described in a supplement to the PBA. The framework proposes measurable targets for sediment routing through the reservoir at the HHD project. To achieve these targets, the Corps proposed to develop a plan providing commitments for monitoring, adaptive management, and modification of operations to ensure achievement of the sediment routing targets.

II. PROPOSED ACTION

City of Tacoma Public Utilities, Tacoma Water has prepared a multiple species HCP to comply with the federal Endangered Species Act (Act)(16 U.S.C. 1531 et seq.) and address water and forestry resource management issues. The 50 year-plan will cover Tacoma's water supply operations at their headworks facility and timber resource management actions on 14,888 acres of Tacoma owned lands in the upper Green River Watershed. The HCP is a set of habitat conservation measures and stewardship actions designed to avoid, minimize, and mitigate the effects of Tacoma's water withdrawal and forestry management activities on the Green River and in the upper Green River Watershed.

Tacoma's habitat conservation measures and stewardship actions are summarized in Table 5.1 of the HCP. The HCP divides the measure into three distinct categories: 1) Type 1 - implementation measures designed to offset or compensate for impacts resulting from Tacoma's water withdrawal actions; 2) Type 2 - contribution of funds and/or implementation of measures designed to offset or compensate for impacts from non-Tacoma actions (i.e. gravel nourishment); and 3) Type 3 - implementation of mitigation and restoration measures in the Green River Watershed designed to offset impacts of Tacoma non-water withdrawal activities (i.e. forestry operations). The list of habitat conservation measures and stewardship actions committed to in the HCP by Tacoma reflects, in part, commitments made by Tacoma in the 1995 Muckleshoot Indian Tribe/Tacoma Public Utility Mitigation Agreement (Appendix B in Tacoma 2001).

A. HCP Plan Area

The action area for this biological and conference opinion, by regulation (50 C.F.R. 402.02) includes "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." The proposed Federal action, in this case, is the issuance of an incidental take permit (Permit) under section 10 of the Act. The action area by definition is Tacoma Water's ownership in the Upper Green River Watershed as well as the entire Green River from its headwaters to the point of tidal influence at approximately river mile 11.0.

B. Summary of HCP Actions

1. <u>Maintenance and Ongoing Operations</u>

Howard Hanson Dam (HHD) was completed in 1962 by the Corps to provide downstream flood protection and augment flows in the lower Green River. The project is located in southeastern King County, approximately 45 miles from Seattle, Washington (Figure 2-1). The dam is located at River Mile (RM) 64.5 in Section 28, Township 21 North, Range 8 East, Willamette Meridian. The project site lies within the City of Tacoma (Tacoma) municipal watershed and access to much of the over 220 square miles of watershed above HHD is closed to the public.

From RM 64.5, the Green River flows west and north from the Cascade Mountains to join with the Black River to form the Duwamish River. The Duwamish River then empties into Puget Sound 12 miles downstream at Elliott Bay.

HHD is currently operated to provide winter and spring flood control and summer low-flow augmentation for fish resources. Flood control operations are managed so that the dam release combined with downstream inflow doesn't exceed 12,000 cubic feet per second (cfs) at the Auburn U.S. Geological Survey (USGS) gage at RM 32. The dam has flood storage of up to 106,000 acre feet (ac-ft).

Winter operation is determined by flood control requirements. During the spring, the project switches to its secondary purpose of conservation storage for low-flow augmentation. The existing reservoir provides for 25,400 ac-ft of summer/fall storage; 24,200 ac-ft is active storage available for enhancing instream flows below the project. During the switch from flood control to conservation storage the amount of water released from HHD is reduced below the level of inflows, allowing the reservoir to refill. Refill timing and release rates are based on target instream flows that are adjusted yearly in response to the existing weather conditions, snowpack, amount of forecasted precipitation, and input on biological conditions from agency and tribal resource managers (USACE 1998a).

Section 1135 of the Water Resources Development Act of 1986 authorizes fish and wildlife enhancement measures at existing water development projects. The Corps has completed a Section 1135 Project which authorizes an additional 5,000 ac-ft of summer storage at HHD during selected years (e.g., initially during drought conditions expected in one out of five years) for a total active storage volume of 29,200 ac-ft. The project adds incremental habitat benefits by increasing the water supply available to augment low summer flows in the lower Green River, improves debris collection and management, and enhances water quality delivered to Tacoma's downstream municipal water supply diversion. The adaptive management provisions of the 1135 project allow the additional storage frequency to be increased to an annual basis if shown to be beneficial to natural resources.

2. Additional Water Storage Project

The Additional Water Storage Project (AWS) consists of two phases. Together, both phases would provide up to 32,000 additional ac-ft over existing storage by raising the existing summer conservation pool 30 feet (from 1,147 feet to 1,177 feet). Phase I includes construction of the downstream fish passage facility at the dam, and storage would be increased by up to 20,000 ac-ft for municipal water supply. It would also include the optional storage of up to 5,000 ac-ft of water every year for low-flow augmentation purposes to benefit downstream fishery resources. The PBA, the Tacoma HCP, and this Opinion include only Phase 1 of the AWS project.

The AWS, a combined water supply and restoration project, was reviewed by and included a collaborative decision-making process involving the Services, Washington Department of

Ecology (Ecology), Washington Department of Fish and Wildlife (WDFW), the Muckleshoot Indian Tribe (MIT), Tacoma, and USACE. This process resulted in the phased adaptive management plan that provides early outputs of water supply and restoration benefits with an opportunity to review and adjust the project based on experience. The plan includes experimentation, monitoring and analysis, followed by adjustment to the management and operation practices.

Up to 20,000 ac-ft of Phase I municipal and industrial water would be stored in the spring for release during the summer and fall to supply up to 100 cfs (65 million gallons per day (mgd)) for Tacoma's Second Diversion Water Right (SDWR). The water surface elevation of the HHD pool would be raised by 20 feet (from elevation 1,147 feet to 1,167 feet). Tacoma would exercise its SDWR when municipal water is being stored during spring reservoir refill. The stored water would then be released for immediate withdrawal during the summer and fall when Tacoma has a greater need for the water.

Phase I of the AWS includes downstream fish passage facilities at HHD, as well as a number of habitat restoration and mitigation projects. As part of Tacoma's agreement with the Muckleshoot Indian Tribe regarding Tacoma's water rights, Tacoma will trap upstream migrating adult salmon and steelhead at Tacoma's headworks, located 3.5 miles downstream, and transport them for release in or upstream of the HHD reservoir.

3. <u>Integrated Conservation Measures</u>

The proposed action includes the following integrated conservation measures, each of which is fully described in the PBA prepared by the USACE (USACE 2000), the Tacoma HCP (Tacoma 2001), and the Services Final Environmental Impact Statement (FEIS, USFWS and NMFS December 2000). Integrated conservation measures are implemented through a cost-share between the USACE and Tacoma.

1) Manage water storage and release at HHD to minimize adverse effects on salmonids.

> a) maximize outflow through the fish passage facility by minimizing the reservoir refill rate during smolt out-migration and potential use of periodic artificial freshets that mimic natural freshets;
>
> b) increase downstream survival of out migrating salmonids by maintaining a target base flow and provide the option to release periodic freshets during peak out-migration;
>
> c) partially mitigate downstream effects of storage by maintaining a target base flow that improves side channel and lateral mainstem rearing habitats;
>
> d) provide adequate base flows through the steelhead incubation period that protect eggs deposited during higher spawning flows;

e) provide annual storage of 5,000 ac-ft for low-flow augmentation (currently Section 1135 Project water is stored during drought conditions expected once every five years);

f) reconnection of approximately 3.4 acres of side-channel habitat to the mainstem lower Green River;

g) habitat rehabilitation including large woody debris (LWD) placement and excavation or reconnection of off-channel habitats to selected streams between the elevations of 1,177 feet and 1,240 feet.

2) Provide gravel augmentation of up to 8,000 cy downstream of HHD at Palmer and Flaming Geyser.

3) Develop and implement a Sediment Management Plan according to the framework provided in the PBA. The sediment management plan would be developed by the Corps in the first two years after completion of this formal consultation. The framework proposes measurable targets for sediment routing through the reservoir at the HHD project. To achieve these targets, the Corps proposes to develop a plan providing commitments for monitoring, adaptive management, and modification of structures or operations to ensure achievement of the sediment routing targets.

4) Transport all LWD that accumulates at HHD around HHD, including up to five truckloads of smaller woody debris per year.

5) Include temperature control capability in downstream fish passage facility.

6) Construct and operate upstream fish passage at Tacoma's headworks dam.

7) Construct and operate downstream fish passage facility at HHD to operate through the elevation range of 1080 to 1177 feet.

8) Provide the monitoring functions for the above and other elements as described in the PBA.

9) Additional habitat improvement actions:

a) return of the river to its historic channel between RM 83.0 and 84.0 using one or more debris jams/flow deflectors;

b) maintenance of instream and riparian corridor habitat within the reservoir inundation zone (elevation 1,141 feet to 1,167 feet);

c) maintenance of stream and riparian corridor habitat in lower Page Mill Creek, creation of a series of new, smaller ponds, and addition of woody debris to the ponds and stream channel;

d) replacement of culverts that constitute barriers to upstream or downstream fish passage in tributaries to the Green River (locations to be identified from a culvert inventory);

e) improvement of habitat in the mainstem Green River above and below HHD by constructing engineered log-jams and limited excavation to recreate meanders or backwater habitats;

All Phase I restoration and mitigation projects would be monitored for at least 10 years, and some up to 50 years, after implementation depending on the project. Some of the activities also require pre-construction studies and monitoring, which are currently underway or planned. The Corps and Tacoma would cost-share fish passage project monitoring, and Tacoma would entirely fund monitoring and maintenance of the fish and wildlife mitigation and restoration projects. Responsibility for implementation of the monitoring efforts would be shared by Tacoma and the Corps, with the work being conducted by either Tacoma staff, Corps staff, agencies, or contractors. All monitoring activities would be conducted in cooperation with the MIT and federal and state agencies.

C. Covered Activities

1. USACE Activities

The City of Tacoma is requesting coverage for incidental take that may occur as a result of their participation in, or local sponsorship of, activities associated with the Green River Water Supply project but that are the responsibility of the USACE. These activities under a separate consultation between NMFS and the USACE that includes an Incidental Take Statement (NMFS Section 7 Biological Opinion, WSB-00-198, on file at NMFS WSHB office, Lacey, WA). These activities are described below (from the HCP, Table 2-2, *Section 7 (Incidental Take Statement) ESA coverage for USACE activities related to operation of the HHD under the AWS project, and USACE activities under the SSP [Second Supply Project]*.).

1) Storage of Water Behind HHD (existing and proposed AWS project Phase I):

- inundation of reservoir
- alteration of downstream flows
- effects on water quality and sediment, and large woody debris transport
- Release of Water From HHD (existing and proposed AWS project Phase I)

- alteration of downstream flows
- alteration of reservoir level
- effects on water quality and sediment and large wood debris transport
- Construction, Operation and Monitoring of Downstream Fish Passage Facility at HHD

2) Mitigation and Restoration Activities Above and Below Reservoir Associated with AWS Project Phase I (implementation and monitoring):

- annual gravel placement in the Middle Green River
- large woody debris release in the Middle Green River
- flow adjustments
- side-channel improvements
- maintenance of stream corridor habitat within the inundation pool
- wetland and riparian habitat improvements in the reservoir inundation pool and along the pool perimeter
- stream habitat improvements above the inundation pool
- creation of elk forage habitat
- manage upland and riparian forests to promote late-successional forest conditions

3) USACE Permitting (404/10) of Mitigation Activities Associated with the SSP:

- placement of fish habitat structures (boulders/logs) in the Headworks pool
- creation/enhancement of wetland along Green River at RM 32.9

4) USACE Permitting (404/10) of Construction of P5.

2. Tacoma Activities

The following Tacoma Water activities also are requested for coverage under terms and conditions of the Incidental Take Permit (Chapter 2.6, Tacoma 2001). The majority of these activities are exclusive to Tacoma. Certain activities or projects are integrated with USACE activities and represent significant involvement by Tacoma (e.g. monitoring and maintenance of AWS fish habitat restoration projects).

1) Water withdrawal at Tacoma's Headworks (associated with FDWRC and SDWR):

- reduction of flows, with concomitant habitat effects downstream;
- bypass of fish at the Headworks intake; and
- inundation of the impoundment area.

2) Water withdrawal from the North Fork well field:

- potential reduction of flows in the North Fork Green River from RM 1.5 downstream to HHD reservoir.

3) Construction of Headworks improvements:

- raising of the existing diversion dam by approximately 6.5 feet, which will extend the inundation pool to 2,570 feet upstream (RM 61.5) of the Headworks diversion;
- realignment and enlargement of the existing intake and adding upgraded fish screens and bypass facilities for downstream passage;
- reshaping of the Green River channel downstream of the existing diversion to accommodate the installation of an efficient trap-and-haul facility for upstream fish passage;
- installation of a new trap-and-haul facility for upstream fish passage; and installation, monitoring and maintenance of the instream structures in the impoundment for the Headworks dam.

4) Operation of the downstream fish bypass facility at the Headworks.

5) Tacoma watershed forest management based on the Green River Watershed Forest Land Management Plan (Ryan 1996):

   - watershed patrol and inspection;
   - forest road construction, maintenance, and use;
   - forest road culvert removal, replacement, and maintenance (an average of approximately 0.5 mile of new road will be built each year, and approximately 12 miles of new and existing roads will be abandoned over the 50-year term of the HCP);
   - timber harvest and hauling; and
   - silvicultural activities (e.g., planting, thinning, and inventorying trees).

6) Monitoring of downstream fish passage through the HHD Reservoir and fish passage facility.

7) Monitoring and maintenance of AWS project fish habitat restoration projects and AWS project fish and wildlife habitat mitigation projects.

8) Potential restoration of anadromous fish above HHD, and:

   - trap-and-haul of adults returning to the Headworks; and
   - possible planting of hatchery juveniles if found to be beneficial to restoration.

9) All other conservation measures described in Chapter 5 of the HCP.

D. Action Area

The action area for this Opinion, per 50 CFR § 402.02, includes "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." In this case, the proposed Federal action is issuing the ITP for the action described in the final HCP. The action area by definition is Tacoma Water's ownership in the upper Green River Watershed, other lands in the upper Green River Watershed, as well as the Green River from its headwaters to the point of tidal influence at approximately river mile 11.0.

A detailed description of the action area is provided in the FEIS prepared by the Services (USFWS and NMFS 2000).

E. Changed and Unforeseen Circumstances

1. <u>Foreseeable Changed Circumstances</u>

The HCP covers Tacoma's operation of the Green River Project and management of the Green River watershed under ordinary circumstances. In addition, Tacoma and the Services foresee that circumstances could change during the term of this HCP, by reason of such natural events as wildfire, floods, and landslides. The ITP will authorize the incidental take of covered species under ordinary circumstances as well as these changed circumstances, so long as Tacoma is operating in compliance with this HCP, the ITP and the IA. If additional mitigation measures or costs beyond those provided in this HCP are deemed necessary to respond to any changed circumstances, the Services will not require any such measures or costs of Tacoma without Tacoma's prior consent.

The relationship between fire, flood, and other physical and biological processes (disturbance) in the structure and composition of forest communities and stream systems has been appreciated for a considerable period of time (See Franklin & Dyrness 1973; Brown 1985; Henderson *et. al.* 1989; Morrison & Swanson 1990; Agee 1991, Reeves *et al.* 1995). Disturbances that affect the biodiversity and landscape ecology in the Plan Area are usually of moderate intensity and relatively confined in geographic extent and magnitude of impact, but may significantly alter stream and forest habitats. Disturbance, in general, has been a substantive consideration in the development of the HCP. Foremost, the intent of the HCP is to minimize management-related disturbances and create conditions that enable natural disturbances to create productive habitat, particularly in the Upper Green Watershed.

Certain reasonably foreseeable disturbances, however, may be of such a magnitude, occur with such an "impulse", or impact such particular portions of the Plan Area as to require the application of supplemental prescriptions for the protection of the covered species. These changed circumstances and supplemental prescriptions are described below and in Section 3.2.3

of the HCP (Tacoma 2001). The general Habitat Conservation Measures (HCM) that these measures may supplement are described in Section V, Table 4, of this Opinion.

a. Wildfire

Wildfire is a natural event in western Washington, and the continued threat of its occurrence will influence the management of the Upper HCP Area. Low- to mid-elevation forests on the west slope of the Cascade Mountains have natural fire regimes characterized by infrequent, extensive, high-intensity and high-mortality fires (Agee 1993). Most remaining old-growth forests in this zone originated after catastrophic fires less than 750 years ago, suggesting a fire frequency shorter than 750 years. Hemstrom and Franklin (1982) found the majority of forests within Mount Rainier National Park to be over 350 years old, and estimated fire frequency in that area to average 434 years. Natural fire frequencies in the upper Green River watershed are likely less than 434 years because the Green River is lower in elevation than Mount Rainier National Park, and more exposed to dry east winds during the summer.

Lightning is the primary source of wildfire ignition in western Washington. July through September are the months of greatest lightning activity (Agee 1993) and least precipitation in western Washington, and are therefore the most conducive to fire activity, especially if combined with dry east winds of the type common to the Green River watershed. Intensive forest management and aggressive fire suppression have reduced the frequency of large wildfires over the past 100 years, but they have simultaneously increased the risk and frequency of small fires. Logging, slash disposal, recreation, transportation (e.g., roads and railroads) and vandalism all combine with lightning to maintain the presence of forest fire. Fire prevention and suppression will continue in the Upper HCP Area because of the severe economic, biological and water quality implications of losing large patches of forest habitat, but these activities will not eliminate wildfire altogether.

Tacoma's actions to prevent and suppress wildfires in the Upper HCP Area will be covered activities under the ITP, and Tacoma will respond to wildfire consistent with the mitigation measures described in Section 5 of this HCP. No measures beyond those listed below will be required to respond to the occurrence of wildfire in the HCP Area:

- Tacoma will take all necessary steps to suppress wildfires that originate on or near the HCP Area. Fire suppression activities conducted by Tacoma will be consistent with the mitigation measures of this HCP to the extent that such compliance does not materially hamper or prevent efforts to suppress fires.

- In accordance with Measure HCM 3-01F, Tacoma will conduct no post-wildfire salvage logging in the Natural Zone, in conifer stands over 100 years old in the Conservation Zone, in Upland Management Areas or in no-harvest riparian and wetland buffers.

- Burned areas in the Commercial Zone will be salvaged in accordance with Measure HCM 3-01F (Salvage Harvesting) and Measure HCM 3-01G (Snags, Green Recruitment Trees and Logs).

- Burned areas in the Commercial Zone that resemble even-aged harvests (i.e., fewer than 50 healthy dominant or codominant conifers per acre, on average) will be reforested in accordance with Measure HCM 3-01M.

- Tacoma will reforest burned areas in the Natural Zone, the Conservation Zone, no-harvest riparian buffers, and UMAs if Tacoma, the USFWS or NMFS determines reforestation is necessary to protect water quality or achieve the mitigation objectives of the HCP for one or more covered species.

- Tacoma will inspect all stream crossing structures (e.g., culverts and bridges) in the HCP Area downstream of burned areas to ensure the structures are appropriately sized, constructed and maintained to accommodate any anticipated increases in flows resulting from wildfire.

- Temporary roads and trails constructed for fire suppression will be re-graded and re-vegetated within one year of creation, unless Tacoma determines a fire road should be made permanent. Temporary fire roads that are made permanent will conform to all HCP requirements for permanent roads.

b. Wind

Wind is an ever-present factor in the HCP Area. Daily winds control the climate, growing conditions, and fire danger in the HCP Area, while seasonal storms can damage or destroy capital improvements, interrupt electrical power and uproot trees. In forested portions of the HCP Area, wind can create habitat for fish and wildlife by killing live trees and/or toppling trees to create logs or large woody debris in streams. Extreme winds can eliminate habitat, however, by blowing down all or most trees in a given area. Tacoma will minimize the impact of wind on the effectiveness of the HCP through the following measures:

- Tacoma's facilities for water withdrawal and fish mitigation will continue to be built to withstand all wind storm events that can reasonably be expected over the term of the HCP. No additional measures are necessary to prepare for or respond to wind damage to Tacoma facilities.

- All Tacoma facilities requiring the use of electrical power, including those to maintain fish flows and facilitate fish passage in the Green River, will be provided with emergency generators. Temporary local power failures will not prevent Tacoma from fulfilling the mitigation requirements of this HCP.

- In accordance with Measure HCM 3-01F, Tacoma will conduct no salvage logging of trees damaged or toppled by wind in the Natural Zone, in conifer stands over 100 years old in the Conservation Zone, in Upland Management Areas or in no-harvest riparian and wetland buffers.

- Trees damaged or toppled by wind in the Commercial Zone will be salvaged in accordance with Measure HCM 3-01F (Salvage Harvesting) and Measure HCM 3-01G (Snags, Green Recruitment Trees and Logs).

- Areas damaged by wind in the Commercial Zone that resemble even-aged harvests (i.e., fewer than 50 healthy dominant or codominant conifers per acre, on average) will be reforested in accordance with Measure HCM 3-01M.

- Tacoma will reforest areas damaged by wind in the Natural Zone, the Conservation Zone, no-harvest riparian buffers, and UMAs if Tacoma, the USFWS or NMFS determines reforestation is necessary to protect water quality or achieve the mitigation objectives of the HCP for one or more covered species.

c. Landslide

Landslides occur naturally in the HCP Area, but the size and frequency of landslides can be increased by human activities that remove stabilizing vegetation from hillsides, alter patterns of surface water run-off and/or alter surface contours. Several of the mitigation measures in this HCP have been specifically designed to minimize the rate of human-caused landslides in the Upper HCP Area and minimize the environmental damage from natural and human-caused landslides. No additional measures will be necessary in the event of a landslide during the term of the HCP. Measures in the HCP to minimize the occurrence and impact of landslides are:

- Watershed Analyses are being conducted for the Upper HCP Area as stated in Measure HCM 3-03A. Included in the Watershed Analyses is a module to identify potential mass-wasting areas and develop prescriptions for minimizing any management-related increases in the rate of land sliding.

- As noted in Measure HCM 3-03C, Tacoma will construct no temporary or permanent roads across unstable soils in the Upper HCP Area, as identified through Watershed Analysis.

- Tacoma will use full bench construction (with no side-casting) when constructing new roads on side slopes of more than 60 percent (Measure HCM 3-03D), to minimize the potential of destabilizing slopes and causing landslides.

- Tacoma will mulch and/or seed road cuts and fills on slopes over 40 percent, cuts and fills near water crossings and in any other locations where there is a potential for erosion and/or slumping (Measure HCM 3-03E).

- Tacoma will abandon roads in the Upper HCP Area that are no longer needed (Measure HCM 3-03I), to eliminate the risk of erosion and slope failure associated with these roads.

- Tacoma will maintain the no-harvest Natural Zone around Howard Hanson Reservoir and along the Green River and its major tributaries (Measure HCM 3-01B), and an extensive network of no-harvest and partial-harvest buffers along all other streams in the HCP Area (Measures HCM 3-02A and 3-02B). These buffers will, among other things, capture sediment and debris from landslides and slumps before this material reaches surface waters.

- Tacoma will conduct no timber harvesting in the Natural Zone (Measure HCM 3-01B), limited harvesting in the Conservation Zone (Measure HCM 3-01C) and harvesting on an extended 70-year rotation in the Commercial Zone (Measure HCM 3-01D). This extremely conservative approach to forestland management will result in a significant portion of the watershed in mature forest at all times, and minimize the effects of timber harvesting and roads on the hydrologic regime of the Upper Green River watershed.

- Tacoma will implement a culvert inspection and replacement program (Measure HCM 3-03J), to ensure that under-sized or improperly placed culverts do not contribute to landslides or slope failures.

d) Flood

The Green River has a history of flooding that was significantly reduced with the construction of Howard Hanson Dam in 1962. The congressionally authorized purpose of this dam is flood control. By providing up to 106,000 acre-feet of flood storage from approximately October through March, the dam has nearly eliminated the threat of flood (i.e., the dam is designed to prevent flows from exceeding 12,000 cfs at the USGS gage at RM 32 in Auburn).

All physical structures needed for Tacoma to carry out the fish mitigation measures of this HCP (e.g., upstream fish passage, bypass facilities, etc.) will be located at or below Howard Hanson Dam, where they are at little risk of flooding. No special measures will be needed to respond to the effects of flooding in these areas. Similarly, instream fish mitigation measures to be implemented downstream of Howard Hanson Dam (e.g., wetland and floodplain restoration, maintenance of minimum flows, and placement of large woody debris in the river) will be designed to accommodate the maximum flows released by the dam (12,000 cfs at RM 32). They also will be monitored to ensure they remain effective after peak flows. No additional measures are necessary.

Natural floods can occur in the Upper HCP Area, upstream of the influence of Howard Hanson Dam. The effects of natural floods in the Upper HCP Area will be minimized by measures to maintain properly-sized culverts (Measure HCM 3-03J), measures to limit the removal of mature forest vegetation (Measures HCM 3-01B, 3-01C, 3-01D, 3-01H and 3-01I), and measures to maintain no-harvest and partial-harvest buffers along streams (Measures HCM 3-02A and 3-02B). No additional measures will be necessary to respond to floods during the term of the HCP.

e. Forest Health

A significant portion of the mitigation for covered activities in the Upper HCP Area involves the management and retention of mature forest habitat on Tacoma lands. While insects and tree diseases are natural components of the coniferous forest ecosystems of western Washington, severe outbreaks of either can threaten the health of these forestlands, and influence the effectiveness of the related mitigation measures. Tacoma will allow insects and tree disease pathogens to persist as natural elements of the HCP Area, but Tacoma also will take reasonable steps to prevent widespread tree mortality in the event of a serious outbreak, including:

- Tacoma may choose to use forest pesticides and fungicides to reduce or stop an outbreak of insects or pathogens in the HCP Area, where such use does not result in the incidental take of a listed species or impact the municipal water supply. The use of pesticides and fungicides is not a covered activity under the ITP. Such use will be at the discretion of Tacoma, subject to all necessary permits and approvals.

- In the event that forest insects or disease pathogens result in the widespread death of trees in the HCP Area, Tacoma will salvage dead and damaged timber consistent with Measures HCM 3-01F (Salvage Harvesting) and HCM 3-01G (Snags, Green Recruitment Trees and Logs). Such salvage harvesting will occur only in the Commercial Zone (outside no-harvest riparian/wetland buffers and UMAs), or in stands less than 100 years old in the Conservation Zone.

- Affected areas in the Commercial Zone that resemble even-aged harvests (i.e., fewer than 50 healthy dominant or codominant conifers per acre, on average) will be reforested in accordance with Measure HCM 3-01M.

- Tacoma will reforest affected areas in the Natural Zone, the Conservation Zone, no-harvest riparian buffers, and UMAs if Tacoma, the USFWS or NMFS determines reforestation is necessary to protect water quality or achieve the mitigation objectives of the HCP for one or more covered species.

f. Changes in the Structure and/or Operation of HHD

Howard Hanson Dam is currently operated to provide flood control to the Green River below RM 64.5. Under the terms of agreements between Tacoma and the USACE, the dam will also be operated in the future to store and release water for municipal water supply and instream fish flows. It is not anticipated that Howard Hanson Dam will be prevented from fulfilling its flood control or flow management commitments over the term of this HCP, but legal or natural forces could intervene. If the operation of Howard Hanson Dam is altered by a natural occurrence (e.g., earthquake), accident, act of war or terrorism, change in USACE policy or management direction, act of Congress, or decision of the courts, Tacoma will only be obligated to fulfill the provisions of the HCP to the extent it is capable of under the changed operating circumstances without jeopardizing its obligation to protect public health and safety through the supply of water.

g. Eminent Domain Affecting Lands within the HCP Area

The Green River HCP Area is surrounded by private and public lands, and crossed by multiple transportation and utility corridors, including roads, railroads, powerlines, and pipelines. It is likely one or more parties having the power of eminent domain may acquire or affect lands within the HCP Area for the purpose of creating or extending an existing road, railroad, public utility, or other public purpose. This could occur through eminent domain, or through voluntary transfer by Tacoma under threat of eminent domain. In the event lands within the HCP area are acquired or affected by any exercise of the power of eminent domain, Tacoma will not be obligated by the HCP or ITP to replace any mitigation provided by such lands. The incidental take coverage for such lands and corresponding HCP obligations may, at the discretion of the Services, be negotiated with and transferred to the recipient of such lands.

2. Unforeseen Circumstances

Unforeseen circumstances are those changes in habitats, conditions, or species status that could not be reasonably anticipated at issuance of the ITP. These circumstances are generally described in the Services' "Habitat Conservation Plan Assurances Rule" (63 FR 8859), and are incorporated in Section 4.2.2 of the IA.

III. STATUS OF ANADROMOUS FISH SPECIES COVERED UNDER THE HCP

A. ESA Status of the Anadromous Fish Species

Thirty aquatic species and 21 wildlife species have been proposed for coverage and conservation under the ESA through the provisions of the HCP and IA (Tacoma 2001). Of nine fish species, six species are under NMFS jurisdiction. These species are listed in Table 1 along with their pertinent history of ESA decisions, designations of critical habitat, and status reviews. The effects of the proposed action on all other aquatic and wildlife species are addressed in the USFWS Biological Opinion and Conference Report (USFWS, July 2001).

Table 1. Status, history of listing and critical habitat designations under the ESA, and pertinent status reviews for six species occurring within the Tacoma Water HCP action area.

Species - Evolutionarily Significant Unit	Proposed Listing	Listing Decision / Critical Habitat Designation	Status	Status Review
Chinook salmon Puget Sound	63 Fed. Reg. 11482 March 9, 1998	64 Fed. Reg. 14308 March 24, 1999 / 65 Fed. Reg. 7764 Feb. 16, 2000.	**Threatened**	Myers *et al.* 1998
Coho salmon Puget Sound / Strait of Georgia		62 Fed. Reg. 37560 July 14, 1997	Candidate	Weitkamp *et al.* 1995
Chum salmon Puget Sound / Strait of Georgia		63 Fed. Reg. 1174 March 10, 1998	Not Warranted	Johnson *et al.* 1997
Pink salmon Odd year		60 Fed. Reg. 51928 Oct. 4, 1995	Not Warranted	Hard *et al.* 1996
Sockeye salmon			No ESU designation	Gustafson *et al.* 1997
Steelhead trout Puget Sound		61 Fed. Reg. 41541 August 9, 1996	Not Warranted	Busby *et al.* 1995, 1996

B. Biological Information

Anadromous salmonids were historically found throughout the Plan Area. The relevant biological requirements are those necessary for salmon species in the Plan Area (see Table 1) to survive and recover to naturally reproducing population levels at which time protection under the ESA would become unnecessary. Adequate population levels must safeguard the genetic diversity of the listed stock, enhance their capacity to adapt to various environmental conditions, and allow them to become self-sustaining in the natural environment.

Information related to biological requirements for each species may be found in Status Reviews listed in Table 1. Presently, the biological requirements of listed species are not being met under the environmental baseline. To improve the status of the listed species, significant improvements in the environmental conditions of designated critical habitat are needed.

The status of six salmonid species covered under the HCP and Incidental Take Permit (Table 1) are described below and analyzed, as warranted, in the following sections of this Opinion.

1. <u>Puget Sound Chinook ESU - Threatened</u>

West coast chinook salmon have been the subject of many Federal ESA actions, which are summarized in the proposed rule (63 Fed. Reg. 11482, March 9, 1998) and in a final rule for listing chinook ESUs in Washington and Oregon (64 Fed. Reg. 14308, March 24, 1999). A complete status review was conducted by the NMFS (Myers *et al.* 1998) that identified fifteen ESUs from Washington, Oregon, Idaho, and California. Based on this review, and considering efforts to being made to protect chinook salmon, NMFS proposed two ESUs as endangered (Washington Upper Columbia River spring chinook and California Central Valley spring chinook) and five ESUs as threatened (Puget Sound, Lower Columbia River, Southern Oregon and California Coastal, Upper Willamette River spring, and California Central Valley fall/late-fall run chinook salmon). In addition, the Snake River fall-run chinook ESU was revised to include Deschutes River (OR) fall-run chinook salmon and the proposal made to list that ESU as threatened. Substantial scientific disagreement existed about the Snake River fall-run chinook, California Central Valley spring chinook, Southern Oregon and California Coastal, and California Central Valley fall/late-fall run chinook salmon and extended the period for making final determinations about these ESUs. After receiving additional comments and information and revising the status review of chinook salmon (NMFS 1998a) the NMFS made its final determinations about chinook on March 24, 1999 (64 Fed. Reg. 14308).

The Puget Sound chinook salmon ESU encompasses all runs of chinook salmon in the Puget Sound region from the North Fork Nooksack River to the Elwha River on the Olympic Peninsula. The boundaries of the Puget Sound chinook ESU correspond generally with the boundaries of the Puget Lowland Ecoregion (see Franklin and Dyrness 1988). The Elwha River, which is in the Coastal Ecoregion, is the only system in this ESU that lies outside the Puget Sound Ecoregion. Coincidentally, the boundary between the Washington Coast and Puget Sound

ESUs (which includes the Elwha River in the Puget Sound ESU) corresponds with ESU boundaries for steelhead and coho salmon.

The NMFS conducted a thorough status review of Puget Sound chinook (Myers *et al.* 1998) from which much of the following information is restated. Chinook salmon in this area all exhibit an ocean-type life history. Although some spring-run chinook salmon populations in the Puget Sound ESU have a high proportion of yearling smolt emigrants, the proportion varies substantially from year to year and appears to be environmentally mediated rather than genetically determined. Puget Sound stocks all tend to mature at ages 3 and 4 and exhibit similar, coastally-oriented, ocean migration patterns. There are substantial ocean distribution differences between Puget Sound and Washington coast stocks, with Coded Wire Tags from Washington Coast fish being recovered in much larger proportions from Alaskan waters. The marine distribution of Elwha River chinook salmon most closely resembled other Puget Sound stocks, rather than Washington coast stocks, and, considering other factors, included this stock in the Puget Sound ESU. The NMFS concluded that, on the basis of substantial genetic separation, the Puget Sound ESU does not include Canadian populations of chinook salmon.

Overall abundance of chinook salmon in this ESU has declined substantially from historical levels, and many populations are small enough that genetic and demographic risks are likely to be relatively high. Contributing to these reduced abundances are widespread stream blockages, which reduce access to spawning habitat, especially in upper reaches. Both long- and short-term trends in abundance are predominantly downward, and several populations are exhibiting severe short-term declines. Spring-run chinook salmon populations throughout this ESU are all depressed.

a. Life History

Chinook salmon are the largest of the Pacific salmon. The species' distribution historically ranged from the Ventura River in California to Point Hope, Alaska in North America, and in northeastern Asia from Hokkaido, Japan to the Anadyr River in Russia (Healey 1991). Additionally, chinook salmon have been reported in the Mackenzie River area of northern Canada (McPhail and Lindsey 1970). Of the Pacific salmon, chinook salmon exhibit arguably the most diverse and complex life history strategies. Healey (1986) described 16 age categories for chinook salmon, 7 total ages with 3 possible freshwater ages. This level of complexity is roughly comparable to sockeye salmon (*O. nerka*), although sockeye salmon have a more extended freshwater residence period and utilize different freshwater habitats (Miller and Brannon 1982, Burgner 1991). Two generalized freshwater life-history types were initially described by Gilbert (1912): "stream-type" chinook salmon reside in freshwater for a year or more following emergence, whereas "ocean-type" chinook salmon migrate to the ocean within their first year. Healey (1983, 1991) has promoted the use of broader definitions for "ocean-type" and "stream-type" to describe two distinct races of chinook salmon. This racial approach incorporates life history traits, geographic distribution, and genetic differentiation and provides a valuable frame of reference for comparisons of chinook salmon populations.

The generalized life history of Pacific salmon involves incubation, hatching, and emergence in freshwater, migration to the ocean, and subsequent initiation of maturation and return to freshwater for completion of maturation and spawning. Juvenile rearing in freshwater can be minimal or extended. Additionally, some male chinook salmon mature in freshwater, thereby foregoing emigration to the ocean. The timing and duration of each of these stages is related to genetic and environmental determinants and their interactions to varying degrees. Salmon exhibit a high degree of variability in life-history traits; however, there is considerable debate as to what degree this variability is the result of local adaptation or the general plasticity of the salmonid genome (Ricker 1972, Healey 1991, Taylor 1991). More detailed descriptions of the key features of chinook salmon life history can be found in Myers *et al.* (1998) and Healey (1991).

This Puget Sound chinook salmon ESU encompasses all runs of chinook salmon in the Puget Sound region from the North Fork Nooksack River in the east to the Elwha River on the Olympic Peninsula. Chinook salmon in this area all exhibit an ocean-type life history. Although some spring-run chinook salmon populations in the Puget Sound ESU have a high proportion of yearling smolt emigrants, the proportion varies substantially from year to year and appears to be environmentally mediated rather than genetically determined. Puget Sound stocks all tend to mature at ages 3 and 4 and exhibit similar, coastally-oriented, ocean migration patterns.

b. Population Trends

The 5-year geometric mean of spawning escapement of natural chinook salmon runs in North Puget Sound for 1992-96 is approximately 13,000. Both long- and short-term trends for these runs were negative, with few exceptions. In South Puget Sound, spawning escapement of the natural runs has averaged 11,000 spawners. In this area, both long- and short-term trends are predominantly positive.

The Puget Sound chinook salmon ESU is large and complex, comprising many individual, discrete populations spread among the major Puget Sound region watersheds. WDF *et al.* (1993) identified 28 stocks that were distributed among five geographic regions and 12 management units or basins (Table 2). (The Hoko River stock was included in WDF's initial inventory, but was subsequently assigned to the neighboring ESU.) NMFS is currently engaged in delineating the population structure of PS chinook and other ESUs as an initial step in a formal recovery planning effort that is now underway. These determinations have not been finalized at this time, but it is likely that these 28 stocks represent the greatest level of potential stratification and that some further aggregation of these stocks is possible.

Puget Sound includes areas where the habitat still supports self-sustaining natural production of chinook, areas where habitat for natural production has been irrevocably lost, and areas where chinook salmon were never self-sustaining. In addition, the Puget Sound contains areas where indigenous local stocks persist and areas where local stocks are a composite of indigenous stocks and introduced hatchery fish that may or may not be of local origin. In some areas where natural production has been lost, hatchery production has been used to mitigate for lost natural production. In response to these varied circumstances, the state and tribal co-managers are developing approaches to categorize stocks to provide a context for analyzing hatchery and harvest actions and considering recovery efforts.

Chinook salmon within the Duwamish/Green River basin originated from both naturally producing native and hatchery fish (i.e., are of "mixed origin"). However, the hatchery stock of chinook salmon is currently believed to have descended from the indigenous run (Grette and Salo 1986). Escapement in the mainstem Green River averaged 7,600 from 1987 through 1992 with a trend toward increasing escapement (WDFW *et al.* 1994). In its review of the chinook salmon, NMFS classified the Green River stock as healthy based on high levels of escapement (Myers *et al.* 1998). NMFS is reconsidering its classification of Green River chinook, however, because of the significant proportion of stray hatchery fish in the naturally spawning population (Derek Poon, pers. comm., as cited in the NMFS Section 7 Biological Opinion, WSB-00-198, on file at NMFS WSHB office, Lacey, WA). The NMFS considers that hatchery stray rates exceeding 9% are inconsistent with viable self-sustaining natural populations. The Green River hatchery stray rate is estimated to exceed 30%, but the extent that natural production is actually sustained by hatchery straying is unknown.

Chinook salmon were historically distributed throughout the accessible reaches of the Green River watershed. Since about 1912, chinook have been confined to the section downstream of Tacoma's headworks water diversion dam near River Mile 61, which blocks upstream passage. Naturally spawning chinook salmon occur in the Green River from downstream of Auburn up through the gorge to just below the headworks dam. A preponderance of the natural spawning occurs in Soos Creek and just downstream of the its confluence with the mainstem Green. Juvenile chinook rearing is distributed throughout the accessible portions of the river, its side channels, and tributaries. Chinook abundance upstream of the lower gorge is generally low because of smaller spawning escapements to this reach of the river. Chinook are not found upstream of the headworks dam or Howard Hanson Dam except when juvenile fish have been deliberately stocked there. Access above the headworks dam ended in 1912, and Howard Hanson was developed in 1962, after the upper basin population segment was extirpated.

Table 2. Distribution of chinook salmon stocks identified in WDF *et al.* (1993). Stock timing designations are spring (SP), summer (S), fall (F), and summer/fall (SF).

Region of Origin	Management Unit	Stock/Timing
Strait of Juan de Fuca	Strait of Juan de Fuca	Elwha/Morse Cr./SF Dungeness/SP

Region of Origin	Management Unit	Stock/Timing
Hood Canal	Hood Canal	Westside Tribs Eastside Tribs Skokomish
North Sound	Nooksack/Samish	NF Nooksack/SP SF Nooksack/SP Nooksack/F Samish R. /SF
	Skagit Spring	Upper Sauk/SP Suiattle/SP Cascade/SP
	Skagit Summer/Fall	Upper Skagit/S Lower Skagit/F Lower Sauk/S
	Stillaguamish	Stillaguamish/S Stillaguamish/F
	Snohomish	Snohomish/S Wallace/SF Snohomish/F Bridal Veil Cr/F
Mid-Sound	Lake Washington	Issaquah/SF N Lake WA Tribs/SF Cedar/SF
	Duwamish/Green	Duwamish/Green/SF Newaukum Cr/SF
South Sound	Puyallup	White River/SP White River/SF Puyallup River /SF S. Prairie Ck. /SF
	Nisqually	Nisqually River/SF
	South Sound Tribs	South Sound Tribs/SF

Recently, the NMFS completed formal Section 7 consultations that considered various stocks to possibly be indigenous and genetically unique, or to be persisting where indigenous stocks may no longer exist, but where sustainable stocks existed in the past and where the habitat could still support such stocks (NMFS 1999, 2000). Further investigations will seek to identify remnant indigenous stocks which, if found, would identify them as the most locally adaptable stock to be utilized in the reestablishment of naturally sustainable populations. Drawing from the Biological Opinions cited above, chinook stock status ranges from healthy to critical; some stocks are severely limited by the available habitat. The range of hatchery influence varies from completely dependant to stocks that are largely unaffected by hatchery strays Circumstances pertinent to the status of each stock varies considerably. Some stocks (e.g. Dungeness and Nooksack) have fallen to such low levels that maintenance of genetic diversity may be at risk. Other stocks are more robust and the abundance levels are above what is needed to sustain genetic diversity, but often not at levels that will sustain maximum yield harvest rates. All of these stocks have escapement goals, which are actively managed for, but have not generally been achieved in recent years. In some cases (Elwha, Dungeness, Nooksack, Stillaguamish, and White River) hatchery operations are essential for recovery, and without them, the stocks would likely further decline and go extinct. In one case at least (Green River) the number of hatchery fish spawning naturally is a concern, in part because it masks evaluations of the actual productivity of wild fish.

2. Puget Sound/Strait of Georgia Chum ESU - Unlisted Species

The Puget Sound/Strait of Georgia chum salmon ESU (fall chum) is comprised of fall spawning populations that occur within the action area and includes all naturally spawned populations of chum salmon from Puget Sound and the Strait of Juan de Fuca up to and including the Elwha River. Fall chum are genetically distinct from Hood Canal summer chum ESU described above. Genetic differences between summer chum and all other chum stocks in the U.S. and British Columbia are a result of long-standing reproductive isolation of the Hood Canal and Strait of Juan de Fuca summer chum populations (Tynan 1992). This isolation has been afforded by a significantly different migration and escapement timing, and geographic separation from other chum stocks in the Pacific Northwest (Tynan 1992, Johnson *et al.* 1997).

a. Life History and Habitat Requirements

Chum salmon, known for the large teeth and calico-patterned body color of spawning males, have the widest geographic distribution of any Pacific salmonid (Johnson *et al.* 1997). In North America, chum range from the Sacramento River in Monterey, California to Arctic coast streams (Salo 1991). Green River chum salmon, along with chum stocks from the Puget Sound and as far west as the Elwha River, were placed into the Puget Sound/Strait of Georgia ESU by the National Marine Fisheries Service (Johnson *et al.* 1997). The average chum harvest from 1988-1992 for this ESU was an estimated 1.185 million fish, equating to a total abundance of 1.5 million fish (Johnson *et al.* 1997).

Chum salmon migration into the Green River begins in early September and continues through December (Figure A-1). Upstream migration can be very fast, with rates of 30 miles per day recorded (Salo 1991). Spawning in the Green River takes place from early November through mid-January. Preferred spawning areas are in groundwater-fed streams or at the head of riffles (Grette and Salo 1986). The major spawning areas in the Green River are the braided section of the mainstem below the Gorge and most major tributaries (Grette and Salo 1986). In general, chum salmon are reported to spawn in shallower, low-velocity streams and side channels more frequently than other salmon species (Johnson *et al.* 1997). Dunstan (1955) reported that most chum seemed to be produced in Burns and Newaukum creeks rather than the mainstem river. While their capture process could not differentiate between fry produced in side channels, tributaries, and mainstem habitats, spawning surveys during the 1950s identified large numbers of chum spawning in Burns Creek. Muckleshoot Indian Tribal biologists surveyed the Green River from 1996-1998 and reported significant numbers of chum spawning in side channels in the middle and lower Green River reaches (E. Warner, pers. comm. 1998, as cited in Tacoma 2001).

The length of incubation of chum eggs is influenced by water temperature, stream discharge, dissolved oxygen, gravel composition, and spawning time (Salo 1991). Eggs at 15˚C hatch approximately 100 days before eggs incubated at 4˚C. Incubation in the Green River takes place from the beginning of November to mid-April (Figure A-1). Success and health of the emergent fry is also dependent on dissolved oxygen, gravel composition, spawner density, stream discharge, and genetic characteristics (Salo 1991).

Juvenile chum salmon have an ocean-type early life history, rearing in freshwater for only a few days to weeks before migrating downstream to saltwater (Grette and Salo 1986; Johnson *et al.* 1997). Chum fry that migrate to sea within several days after emergence exhibit little growth, but fry that rear for longer periods may exhibit an increase in length up to 22 percent in less than 4 weeks (Hale *et al.* 1985). Hale *et al.* (1985) reported that chum fry grew slowly in March and April when most fry migrated to the sea, but as water temperature increased, growth of remaining fry was more rapid.

Downstream movement in the Green River occurs from mid-February through late May but varies annually. Dunstan (1955) identified an initial small surge of chum fry in late February, but believed the peak of chum fry outmigration occurred between March 20 and April 3. Chum fry were present in juvenile surveys conducted in the middle Green River from February through June, peaking in relative abundance in mid-April, 1998 (R2 1999).

Observations of chum fry abundance in the Duwamish estuary also indicate movement from the Green River, but peak movement in the estuary may be several days or weeks following peak movement in the river. Meyer *et al.* (1980) sampled juvenile salmonids in the Duwamish estuary from early April through early July. They noted an initial peak abundance of chum fry in late April prior to any plants of hatchery chum in the system. A second, larger peak of chum abundance occurred in mid-May, several days after the Muckleshoot Indian Tribe released 750,000 chum fry in Crisp Creek at RM40. Bostick (1955) observed peak abundance of chum in the Duwamish estuary in early May 1953 and Weitkamp and Campbell (1979) observed peak chum abundance in late April, 1978. Using beach seines to collect salmonid fry in the Duwamish estuary during the spring months of 1994, 1995 and 1996, Muckleshoot tribal researchers observed chum fry in the estuary from February through July (E. Warner 1998). During all 3 years of study, they observed peak abundance of chum fry in the estuary in April.

Juvenile chum may remain in the brackish water habitat of the Duwamish estuary for several days to 3 months, moving offshore as food resources decline in the summer (Meyer *et al.* 1981; Grette and Salo 1986). Simenstad *et al.* (1982) reports that eelgrass (*Zostera* spp.) habitats may be a preferred habitat of juvenile chum salmon. Juvenile chum appear to depend heavily on benthic organisms for food while residing in estuaries (Johnson *et al.* 1997). Like fall chinook, their dependency on estuaries as rearing habitat may limit chum production in the Green River Basin (Grette and Salo 1986).

Chum salmon originating from Puget Sound streams appear to enter the ocean earlier than northern counterparts (Johnson *et al.* 1997). Marine movement information is limited for chum salmon, however, commercial fishing records indicate that maturing chum begin to move coastward in May and June (Johnson *et al.* 1997). Chum stocks from the Green River basin are harvested in both pre-terminal and terminal commercial fisheries at a mean combined harvest rate of 8.1 percent (1988 through 1991) (WDFW *et al.* 1994).

b. Known Occurrences in the Plan Area

Two chum stocks are recognized in the Green River system (WDFW *et al.* 1994). The Crisp (Keta) Creek fall chum stock originated from releases of Quilcene and Hood Canal stocks from the Keta Creek Hatchery in the early 1980s. Currently, efforts are being made to replace this stock with south Puget Sound hatchery fish (WDFW *et al.* 1994). The Duwamish/Green stock is thought to be a remnant native stock, however, it is likely that hatchery plants have affected the gene pool (WDFW *et al.* 1994). Abundance figures are not available for the Duwamish/Green River chum stock (WDFW *et al.* 1994). A Washington Department of Fish and Wildlife survey in 1947 counted 452 chum salmon in Burns Creek, prior to hatchery supplementation. Current information on this stock is sparse and it is questionable whether this population currently exists (WDFW *et al.* 1994). There are no Washington Department of Fish and Wildlife escapement goals for the two stocks of chum salmon residing in the Green River.

c. Population Status and Status under the ESA

Green River chum salmon are included in the Puget Sound/Strait of Georgia ESU. Commercial harvest of chum salmon has been increasing since the early 1970s throughout this ESU. This increased harvest, coupled with generally increasing trends in spawning escapement, provides compelling evidence that chum salmon are abundant and have been increasing in abundance in recent years within this ESU (Johnson *et al.* 1997). The NMFS concluded that this ESU is not presently at risk of extinction, and is not likely to become endangered in the near future (63 Fed. Reg. 11778). The Crisp Creek fall chum stock is currently designated as healthy (WDFW *et al.* 1994), but there is some doubt whether native fish still remain. The Duwamish/Green stock, if present, may be a remnant native stock, but their status and origin is presently (WDFW *et al.*

1994). The Crisp Creek stock originated from releases of Quilcene and Hood Canal hatchery stocks, and as such, is considered an introduced hatchery stock (WDFW *et al.* 1994).

3. <u>Puget Sound Steelhead ESU - Unlisted Species</u>

This coastal steelhead ESU occupies river basins of the Strait of Juan de Fuca, Puget Sound, and Hood Canal, Washington. Included are river basins as far west as the Elwha River and as far north as the Nooksack River. No recent genetic comparisons have been made of steelhead populations from Washington and British Columbia, but samples from the Nooksack River differ from other Puget Sound populations, and this may reflect a genetic transition zone or discontinuity in northern Puget Sound. In life history traits, there appears to be a sharp transition between steelhead populations from Washington, which smolt primarily at age 2, and those in British Columbia, which most commonly smolt at age 3. This pattern holds for comparisons across the Strait of Juan de Fuca as well as for comparisons of Puget Sound and Strait of Georgia populations. At the present time, therefore, evidence suggests that the northern boundary for this ESU coincides approximately with the U.S.-Canada border.

Recent genetic data provided by WDFW show that samples from the Puget Sound area generally form a coherent group, distinct from populations elsewhere in Washington. There is also evidence for some genetic differentiation between populations from northern and southern Puget Sound, but the NMFS Biological Review Team (BRT) did not consider that ecological or life history differences were sufficient to warrant subdividing this ESU. Chromosomal studies show that steelhead from the Puget Sound area have a distinctive karyotype not found in other regions.

a. Life History and Habitat Requirements

Steelhead trout, displaying perhaps the most diverse life history pattern of all Pacific salmonids, reside in most Puget Sound streams. Their native distribution extends from the Alaska Peninsula to northern Mexico. Presently, spawning steelhead are found as far south as Malibu Creek, California (62 Fed. Reg. 43937). Two different genetic groups (coastal and inland) of steelhead are recognized in North America (Busby *et al.* 1996). British Columbia, Washington, and Oregon, have both coastal and inland steelhead, while Idaho has only the inland form and California steelhead stocks are all of the coastal variety (Busby *et al.* 1996). Within these groups, steelhead trout are further divided based on the state of sexual maturity when they enter freshwater. Stream-maturing steelhead (also called summer steelhead) enter freshwater in an immature life stage, while ocean-maturing (or winter steelhead) enter freshwater with well developed sexual organs (Busby *et al.* 1996). Green River steelhead (both summer and winter stocks) have been placed into the Puget Sound ESU, along with 53 other steelhead stocks, by the National Marine Fisheries Service (Busby *et al.* 1996). Total run size for the major stocks of this ESU was estimated at 45,000, and natural escapement of approximately 22,000 steelhead (Busby *et al.* 1996).

Summer and winter races of steelhead, are present in the Green River. Winter steelhead runs in

Washington are differentiated by an arbitrary date of 31 October. Steelhead entering the Green River from May through October are considered summer steelhead, while winter steelhead move into the Green River from December through May (Grette and Salo 1986; WDFW *et al.* 1994). Winter steelhead are native to the Green River and spawn from mid-March through June, while summer steelhead (first introduced in 1965 from the Skamania hatchery) spawning occurs from February through March (Grette and Salo 1986; WDFW *et al.* 1994). Hatchery-origin winter steelhead (Chamber Creek stock) generally spawn earlier in the season than do their wild counterparts, often completing spawning by mid-March, thus are not thought to interbreed with wild winter steelhead (WDFW *et al.* 1994).

The greatest number of steelhead redds counted during WDFW surveys in the Green River between 1994 and 1996 were found in late April (Table 3). Winter steelhead spawn in the Green River from approximately RM 26.0 to RM 61.0. Summer steelhead primarily spawn in the mainstream and lower tributary areas from the Headworks (RM 61.0) downstream to the upper gorge (RM 58) (King County Planning Division 1978). An anonymous WDG Report in 1945 (as cited in USACE 1998b) states that historically, at least 90 percent of steelhead spawning and rearing area were located above the City of Tacoma's Headworks at RM 61.0. Since 1982, hatchery raised juveniles have been planted in the Upper Watershed and beginning in 1992, 70-133 adult steelhead have also been released upstream of the HHD (USACE 1998b). Specific information regarding steelhead spawning temporal timing is provided in Table 3, below.

Table 3. Winter steelhead redd count estimate in the mainstem Green River by timing, 1994 – 1996 (adapted from Washington Department of Fish and Wildlife (as presented in Appendix A, Tacoma 2001)).

	1994		1995		1996		Average 1994 - 1996	
Time Period	No. Redds	Percent	No. Redds	Percent	No. Redds	Percent	No. Redds	Percent
March 1 - 15	18.40	2.25%	37.00	3.40%	0.00	0.00%	18.47	1.67%
March 16 - 31	109.60	13.42%	17.02	1.57%	93.81	6.60%	73.48	6.64%
April 1 - 15	218.50	26.75%	166.43	15.31%	309.50	21.79%	231.48	20.91%
April 16 - 30	217.86	26.67%	298.00	27.41%	362.50	25.52%	292.79	26.45%
May 1 - 15	171.82	21.04%	311.05	28.61%	182.63	12.86%	220.78	19.94%
May 16 - 31	60.16	7.37%	188.53	17.34%	333.00	23.44%	193.90	17.51%
June 1 - 15	20.48	2.51%	52.05	4.79%	94.11	6.62%	55.55	5.02%
June 16 - 30	0.00	0.00%	17.00	1.56%	45.00	3.17%	20.67	1.87%
Totals	816.82	100%	1087.08	100%	1420.55	100%	1107.10	100%

In general, steelhead differ from spawning chinook and coho salmon by their use of faster, shallower, and higher gradient locations in mainstem or tributary streams (Everest and Chapman 1972). However, Caldwell and Hirschey (1989) observed steelhead spawning in the Green River in velocities ranging from approximately 2.0 to 4.0 fps, and depths ranging from 1.6 to 3.7 feet.

Caldwell and Hirschey (1989) also report preferred spawning substrate composed of predominantly large gravel, with some small cobble. Pauley *et al.* (1986) found steelhead spawning in gravel ranging from 0.5 to 4.5 inches in diameter.

As with other salmonids, incubation rates for steelhead eggs vary with water temperature, with fry emergence occurring 40 to 80 days after spawning. Unlike other salmonids, steelhead require a relatively short incubation period, for modeling purposes, the time between fertilization and emergence on the Green River was assumed to be 50 days (see USACE 1998b, Appendix FI, Section 6). Dissolved oxygen levels at or near saturation with no temporary reductions in concentration below 5 parts per million are most suitable for incubation (Stolz and Schnell 1991). Everest and Chapman (1972) found age-0 steelhead residing over cobbles in water velocities of <0.5 fps and depths of 0.5 to 1.0 feet. Juvenile steelhead will utilize stream margins and submerged rootwads, debris, large substrate, and logs to provide shelter and cover while rearing in freshwater habitats (Bustard and Narver 1975).

Both winter and summer juvenile steelhead rear in freshwater for 1 or more years before migrating to the ocean (Busby *et al.* 1996). In the Green River, most juvenile steelhead migrate after 2 years rearing in freshwater (Meigs and Pautzke 1941). In general, juvenile downstream migration for steelhead smolts occurs from April through June, with peak migration in general occurring in mid-April (Wydoski and Whitney 1979). An early study of steelhead smolt emigration by Pautzke and Meigs (1940) found that steelhead smolts emigrated from the Green River primarily during April and May. Seiler and Neuhauser (1985) planted steelhead fry in the upper watershed during the fall of 1982 and operated a scoop trap below HHD during 1984 to monitor the outmigration of smolts. They operated the trap at regular intervals between 5 April through 18 June and observed the peak outmigration of steelhead smolts were similar to coho smolts, early May through early. Steelhead trout in smolt condition were captured during juvenile surveys in the middle Green River during the month of May in 1998 (Jeanes and Hilgert 1999). Based on theses studies, the peak juvenile outmigration for the Green River HCP area is assumed to be during May (depicted in the HCP, Figure A-1 (Tacoma 2001)).

Estuaries provide important nursery and schooling environments for juvenile salmonids (Shepard 1981; Simenstad *et al.* 1982). This transition zone allows outmigrant salmonids to physiologically adapt to the full strength saltwater conditions (SRWA 1998, as cited in Tacoma 2001). However, reports that other Puget Sound steelhead smolts move quickly through estuaries, feeding in the mainstem before migrating to the ocean indicate that they do likewise in the Green-Duwamish estuary (Emmett *et al.* 1991; SRWA 1998). Meyer *et al.* (1980) captured more than 7,700 juvenile salmonids in surveys conducted in the Duwamish estuary. Of these, only 50 were steelhead, representing less than 1 percent of the total number of salmonids captured from April through July, 1980, furthering the idea that steelhead do not reside in estuarine habitats for extended periods of time.

Most (60-75 percent) of the steelhead originating from Washington streams remain at sea for two years prior to prior to returning to freshwater, the remaining balance spend three years in the ocean (Grette and Salo 1986). One significant difference between steelhead and Pacific salmon life history is that not all steelhead adults die after spawning. Steelhead are capable of repeat spawning (iteroparous), although the incidence is relatively low and specific to individual streams. Steelhead rarely spawn more than twice before dying, most that do are females (61 Fed. Reg. 41541). Repeat spawning in Washington ranges from 4.4 to 14.0 percent of total spawning runs (Wydoski and Whitney 1979). The average 4+ wild Green River steelhead weighed 7 to 8 pounds (Meigs and Pautzke 1941).

b. Known Occurrences in the Plan Area

Two different steelhead stocks were established by Washington Department of Fish and Wildlife in the Green River, including both summer and winter stocks (WDFW *et al.* 1994). The summer steelhead stock originated outside of the basin from plants beginning in 1965 from the Klickitat River (Grette and Salo 1986). Winter steelhead are native to the Green River. Both winter and summer stocks presently receive hatchery supplementation, about 70,000 summer steelhead smolts are released into the Green River system annually (WDFW *et al.* 1994).

The natural spawning stock of winter steelhead is managed for an escapement of 2,000 fish, representing approximately 9 percent of the estimated natural escapement of all steelhead within the Puget Sound ESU. Steelhead in excess of 2,000 are available to the sport and tribal fisheries. Natural spawner escapement has ranged from 944 to 2,778 fish and wild run size has ranged from 1,350 to 3,464 fish from 1978 through 1992 (WDFW *et al.* 1994). The escapement goal for the upper watershed (above HHD) is 650 while an escapement goal of 1,250 was used by USACE (1998b). Returning hatchery adults support tribal and sport fisheries with a combined exploitation rate of approximately 90 percent (WDFW *et al.* 1994). Both winter and summer steelhead stocks in the Green River were rated as healthy by the Washington Department of Fish and Wildlife (WDFW *et al.* 1994).

c. Population Status and Status under the ESA

Green River steelhead have been classified as part of the Puget Sound ESU (1 of 15 west coast steelhead ESU's). Natural fish (wild runs) are the focus of ESU determinations. In the Green River system, the wild winter steelhead population is a distinct stock based on geographic isolation of the spawning population (WDFW *et al.* 1994). Escapement goals have been approximately met or exceeded during 5 of the seasons between 1985 and 1992.

Overall, the status of Green River steelhead populations are considered healthy (WDFW *et al.* 1994). However, there has been a general decline in recent (within the past few years) steelhead populations throughout the Strait of Juan de Fuca, Pacific coast, and Columbia River. The widespread decline in abundance is thought to be due to low ocean productivity, competition for food in the ocean, and high seas drift net fisheries (WDFW *et al.* 1994). National Marine Fisheries Service found that the Puget Sound steelhead ESU is not threatened at this time (see Table 1). However, future population declines may warrant changes in ESA status (Busby *et al.*

1996).

4. Pink Salmon - Unlisted Species

The pink salmon that occur within the Plan Area are part of the odd-year pink salmon populations in Puget Sound and the Strait of Juan de Fuca, Washington, that extend as far west as the Dungeness River (or the Elwha River, if that population is not already extinct) and in southern British Columbia (including the Fraser River and eastern Vancouver Island) as far north as Johnstone Strait. No even-year pink salmon populations occur within the action area, or are thought to have been historically present.

a. Life History and Habitat Requirements

Pink salmon are the most abundant of the seven Pacific salmon species, totaling close to 60 percent by numbers and 40 percent by weight of all commercial catches in the North Pacific Ocean (Heard 1991). Pink salmon, the smallest of the Pacific salmon as adults, have substantial spawning populations distributed along the Pacific Coast from Puget Sound, north to Norton Sound, Alaska (Heard 1991; Hard *et al.* 1996). Historically, small pink runs have also been reported in the Columbia River and as far south as the Sacramento River, California (Heard 1991). Pink salmon are distinguished from other Pacific salmon by their fixed two-year life cycle and the hump that develops on maturing males. The National Marine Fisheries Service used their run-timing to identify two ESUs for pink salmon in Washington and southern British Columbia, the Even-year ESU and Odd-year ESU (Hard *et al.* 1996). Most Washington pink salmon stocks are odd-year fish, although a single even-year run exists on the Snohomish River (Hard *et al.* 1996). Total average escapement (1959-1993) of the 14 odd-year pink salmon stocks occurring in Washington is 888,804 fish (Hard *et al.* 1996).

After spending approximately 18 months at sea, inshore migration of pink salmon begins in June and continues through September. Spawning takes place from August through November and usually occurs closer to the sea than other Pacific salmon, possibly due to the fact that pink salmon are not particularly adept at leaping obstructions (Heard 1991). A large percentage of pink salmon populations spawn intertidally (Hard *et al.* 1996). Pink salmon spawn in riffles with clean gravel, shallower water, and moderate to fast currents (Heard 1991). Substrate preference is for coarse gravel and sand, with a few large cobbles and very little silt (Heard 1991). Pink salmon avoid spawning in quiet deep water, or over heavily silted substrate (Heard 1991). Spawning activity reaches a peak at temperatures around 10˚C.

Incubation of fertilized eggs in gravel interstices lasts between 5 and 8 (Heard 1991). Water quality, egg desiccation, predators, and flooding are some of the major factors influencing egg survival to emergence. Pink salmon eggs hatch in late February, and the young emerge from the gravel in April and May, depending on water temperatures. Like other salmonids, the fry travel predominantly during hours of darkness during their migration downstream to the ocean (Hard *et* *al.* 1996). Pink salmon fry spend less time on average in freshwater than all other Pacific salmon species (Hard *et al.* 1996). Upon reaching the mouth of the stream, increased schooling takes place before pink salmon move into the estuary. Upon arrival in estuarine habitat, young pink salmon tend to remain close to nearshore nursery areas until approximately September (Emmett *et al.* 1991).

Pink salmon migrate at sea for 12-16 months before starting their inland migrations in May through July (Heard 1991). Mature adult pink salmon may grow to a length of 30 inches and weigh, on average, between 3 and 5 pounds. Pink and chum salmon often occur together in marine environments (Heard 1991). Ocean migration can generally be described to occur in a counter-clockwise circle, beginning from the Strait of Juan de Fuca, north to Prince William Sound, Alaska, and back to the Strait of Juan de Fuca (Heard 1991; Hard *et al.* 1996). Unlike chum and sockeye, pink salmon make only one complete cycle of the migration circle (Heard 1991).

b. Known Occurrences in the Plan Area

Prior to the 1930s, odd-year pink salmon were present in the Green River (Grette and Salo 1986). However, for the most part, they have been eliminated from the river system. They have been caught on occasion, and may stray into the Green River from the Puyallup River, which contains a substantial run of pink (WDFW *et al.* 1994). The highest annual number of pink salmon observed in the Green River over the last several decades is 13 (Hard *et al.* 1996). No juvenile pink salmon were captured during electrofishing and fyke net surveys conducted on the middle Green River, RM 34- 45, in 1998 (Jeanes and Hilgert 1999).

c. Population Status and Status under the ESA

Washington and southern British Columbia pink salmon stocks, divided into even- and odd-year ESUs, are not considered warranted for listing at this time, however, several Pacific Northwest streams have experienced depressed pink salmon runs in recent years (Hard *et al.* 1996).

5. <u>Puget Sound Coho Salmon ESU - Unlisted Species</u>

The Puget Sound coho ESU occurs within the action area and includes all naturally spawned populations of coho salmon from drainages of Puget Sound and Hood Canal, the eastern Olympic Peninsula (east of Salt Creek), and the Strait of Georgia from the eastern side of Vancouver Island and the British Columbia mainland (north to and including the Campbell and Powell Rivers), excluding the upper Fraser River above Hope. Weitkamp *et al.* (1995) completed a status review of coho salmon in Washington, Oregon and California. Based on this review, additional information and an extensive public involvement process, the NMFS determined that listing was not warranted for this ESU (60 Fed. Reg. 30811; July 25, 1995).

a. Life History and Habitat Requirements

Coho salmon are one of the most popular and widespread sport fishes found in Pacific Northwest waters. Coho populations exist as far south as the San Lorenzo River, California and north to Norton Sound Alaska (Sandercock 1991). The average size of Puget Sound coho has steadily declined from 1972 (8.8 pounds) through 1993 (4.4 pounds) (Bledsoe *et al.* 1989). Numerous parameters, including harvest practices, are thought to be associated with this decline. Coho originating in the Green River have been placed into the Puget Sound/Strait of Georgia ESU by the National Marine Fisheries Service (Weitkamp *et al.* 1995). This ESU encompasses coho populations from South Puget and Hood Canal to eastern Olympic Peninsula up to the Powell River Basin, British Columbia. Total average run size (from 1965 through 1993) for 17 stocks located in the Puget Sound ESU is 240,795 (Weitkamp *et al.* 1995).

Green River coho migrate upstream from early August through mid-January (Grette and Salo 1986). As with chinook salmon, coho require both deep holding cover for resting and sufficient discharge (water depths of 0.6 ft) to permit upstream movement (Laufle *et al.* 1986).

Coho spawning takes place in the Green River from late September through mid-January (Grette and Salo 1986). Coho spawn in all available tributaries and the mainstem Green River. Mainstem spawning is heaviest in the braided channel reaches near Burns Creek, in the Green River Gorge, and below the Tacoma Headworks. Major spawning tributaries include Newaukum, Big Soos, Crisp, Burns, Springbrook, and Hill creeks (Grette and Salo 1986).

Incubation periods for coho salmon last from 35 to 101 days (Laufle *et al.* 1986; Sandercock 1991). After hatching, larvae typically spend 3 to 4 weeks (depending depth of burial, percentage of fine sediments, and water temperatures) absorbing the yolk sac in gravels before they emerge in early March to mid-May (McMahon 1983; Laufle *et al.* 1986; Sandercock 1991). Newly-emerged coho (e.g., yolk sac fry) were found in the middle Green River on 25 February (Jeanes and Hilgert 1999). Coho fry continued to be present through May, with peak relative abundance occurring in mid-April (Jeanes and Hilgert 1999)

Juvenile coho salmon rear in freshwater for approximately 15 months prior to migrating downstream to the ocean, but may extend their rearing time for up to 2 years (Sandercock 1991). Newly-emerged fry usually congregate in schools in pools of their natal stream. As juveniles grow, they move into more riffle habitat and aggressively defend their territory, resulting in displacement of excess juveniles downstream to less favorable habitats (Lister and Genoe 1970). Aggressive behavior may be an important factor maintaining the numbers of juveniles within the carrying capacity of the stream, and distributing juveniles more widely downstream (Chapman 1962; Sabo 1995). Once territories are established, individuals may rear in selected areas of the stream feeding on drifting benthic organisms and terrestrial insects until the following spring (Hart 1973; Cederholm and Scarlett 1981). Complex woody debris structures and side channels are important habitat elements for YOY coho salmon, particularly during the summer low-flow period on the Green River (Grette and Salo 1986; Jeanes and Hilgert 1999), suggesting that the abundance of juvenile coho is often determined by the combination of space, food, and water temperature (Chapman 1966; Sandercock 1991).

The peak outmigration of coho smolts in the Green River occurs between late April and early June (Figure A-1). Bostick (1955) sampled outmigrating smolts in the Duwamish estuary in 1953 and observed the peak outmigration of coho smolts in late May. Dunstan (1955) observed a peak outmigration of coho smolts during late April. Dunstan (1955) also captured newly emerged fry late February through April but characterized these early movements as being instream redistribution rather than an active seaward migration. Weitkamp and Campbell (1979) and Meyer *et al.* (1980) observed the greatest abundance of coho smolts in the Duwamish estuary during late May. Meyer *et al.* (1980) noted that by early June coho smolts appeared to move quickly through the estuary and that few coho were present in the estuary after June 4.

Observations of peak coho smolt movement in the Duwamish estuary may occur up to several weeks following peak movement through the lower Green River.

During 1983, coho fry were outplanted in the upper watershed and a scoop trap was operated below HHD to monitor the outmigration of coho smolts (Seiler and Neuhauser 1985). The trap was operated at regular intervals between April 5 through June 18 and observed the peak outmigration of coho smolts between early May and early June. Over 90 percent of smolts captured were taken during the hours of darkness. Low catches during the initial days of trapping suggested the migration began during early April, but data on the end of migration were obscured by closure of the main discharge gates at HHD on 6 June. Based on the number of coho yearlings captured during gill net sampling in the reservoir, Seiler and Neuhauser (1985) suggested downstream migration from the upper watershed continues into June.

Peak downstream movement of coho yearlings into the reservoir occurred during May and early June (Dilley and Wunderlich 1992). During 1992 they expanded their trapping activities to extend from mid-February through the end of November. Unusually warm, wet weather during February 1992, and a high early runoff coincided with downstream movement of coho yearlings into the reservoir beginning in late February and extending through May. Even though downstream migration began in February, downstream movement into the reservoir peaked during late April and early May (Dilley and Wunderlich 1993).

Outmigrating yearling coho tend to move quickly through the estuary compared to other salmonid species (Emmett *et al.* 1991). Adult coho generally return to their natal streams to spawn at age 3, after spending 18 to 24 months (up to 3 years) in the marine environment. Coho salmon are an important commercial and recreation species in the Puget Sound, Grette and Salo (1986) report over 150,000 fish from the Green River were reported in the commercial and recreational coho catch during 1981.

b. Known Occurrences in the Plan Area

The coho salmon is considered to be the most numerous anadromous fish in the Green/Duwamish basin (King County Planning Division 1978). Two coho stocks have been identified in the Green River Basin, the Green River/Soos Creek, and Newaukum Creek (WDFW *et al.* 1994). The Green River/Soos Creek stock is of mixed origin. Releases of both native and non-native hatchery-origin coho in this system dates back to the early 1950s. Currently, approximately 3 million yearling coho are released annually from hatchery facilities located on Soos and Crisp creeks. Natural reproduction in Soos Creek is derived from hatchery-origin adults passed above the rack. Production upstream of HHD is derived from off-station fry and fingerling releases. Escapement data for the Green River/Soos Creek coho stock are limited, however run reconstruction data indicates stable escapement and the stock is considered healthy (WDFW *et al.* 1994). Green River coho run size from 1965 through 1993 averaged 11,979 based on run reconstruction, which equates to 5 percent of the total average run size for the Puget Sound ESU (Weitkamp et al. 1995).

Coho returning to Newaukum Creek have been identified as a separate stock within the Green River basin, based on geographic separation and differences in spawning timing (WDFW *et al.* 1994). Multiple peaks within spawning curves, and an extended spawning season suggest that there may be a unique genetic component in the Newaukum Creek Stock. This stock is believed to be a mixture of native and introduced stocks. Production occurs through both natural spawning and a comprehensive fingerling release program. Since 1987, this stock has experienced a severe short-term decline and is considered depressed.

c. Population Status and Status under the ESA

Green River/Soos Creek coho population data indicates stable escapement and production levels, however, the last year of data analyzed (1991) is the lowest in database history, and similar values in the future would quickly bring this stock into the "depressed" category (WDFW *et al.* 1994).

The Newaukum Creek coho stock has experienced short-term severe decline in population that has been limited by summer low flows (WDFW *et al.* 1994). This stock is currently designated depressed status by WDFW *et al.* (1994).

Green River coho stocks were placed in the Puget Sound/Strait of Georgia ESU. Continued loss of habitat, extremely high harvest rates, and a severe recent decline in average spawner size are substantial threats to remaining native coho populations in this ESU. Currently, this ESU is not listed as threatened or endangered. However, because of limited information on many coho stocks in this ESU and risks to naturally producing populations, the Puget Sound/Strait of Georgia ESU was added to the list of candidates for threatened and endangered species. If present trends continue, this ESU is likely to become endangered in the foreseeable future (Weitkamp *et al.* 1995).

6. Sockeye Salmon - Unlisted Species

a. *Life History and Habitat Requirements*

Sockeye salmon are the third most abundant of the seven Pacific salmon species (Burgner 1991). As such, commercial catches of sockeye comprised 17 percent by weight and 14 percent by number of the total salmon catch in the Pacific Ocean from 1952-1976 (Burgner 1991). Historically, accounts of sockeye catches exist for California as far south as the Sacramento River, however, today there are no recognized runs existing in that state (Gustafson *et al.* 1997). Currently, sockeye range from the Deschutes and Willamette rivers in Oregon to Kotzebue Sound, Alaska. Green River sockeye, along with sockeye from 15 other rivers and streams in Washington, were listed as riverine spawning sockeye salmon in Washington by the National Marine Fisheries Service and were not included in one of the six ESU's established in 1997 (Gustafson *et al.* 1997). Other than anecdotal accounts, little information is available on the abundance and/or trends of riverine-spawning sockeye in Washington.

Sockeye salmon exhibit the greatest variety of life history patterns of all the Pacific salmon, and characteristically make more use of lacustrine habitat than other salmon species. Life history patterns of sockeye include: nonanadromous land-locked sockeye, lake type sockeye, and river or sea type sockeye. The landlocked type, called kokanee, mature, spawn and die in freshwater without a period of marine residency (Gustafson *et al.* 1997). Lake-rearing sockeye juveniles typically spend 1-3 years in lacustrine habitats, before migrating to sea (Burgner 1991). Lake rearing stocks represent the most common and typical life history. Sockeye that rear in rivers for 1 to 2 years (river-type sockeye) are less common than the lake-type sockeye, and hence, little is known about them. River type sockeye migrating as fry to saltwater, or lower river estuaries in the same year as emergence, are termed "sea-type" sockeye (Gustafson *et al.* 1997). The distribution of sockeye in Puget Sound known to use rivers for spawning and rearing include the North and South Fork Nooksack, Skagit, Sauk, North Fork Stillaguamish, Samish, and Green River populations (Gustafson *et al.* 1997).

River-spawning sockeye exhibit great diversity in selection of spawning habitat and river entry timing (Gustafson *et al.* 1997). Puget Sound stocks, in general, enter freshwater in June, July, and August (Gustafson *et al.* 1997). Areas containing upwelling of oxygenated water through sand and gravel are important for spawning (Burgner 1991). For a given fish size, sockeye salmon have the highest fecundity (number of eggs), and the smallest egg size of the Pacific salmon (Gustafson *et al.* 1997).

Length of sockeye egg incubation is temperature dependent, but is generally longer than the other salmon species (Burgner 1991). This seems to be due to the choice of spawning environment (Burgner 1991). In general, spawning occurs during periods of declining temperatures, incubation occurs at the lowest winter temperatures, and hatching is associated with rising water temperatures in late winter or early spring (Burgner 1991).

After emergence, juvenile sockeye will migrate to nursery lakes for rearing, or in the case of river-type sockeye, utilize river and estuarine habitat for rearing, or migrate directly to the sea (Burgner 1991). Initially, upon emergence, juvenile sockeye exhibit photonegative response, moving primarily at night, which is believed to be an anti-predator adaptation (Burgner 1991). Smolt outmigration to the ocean also occurs during darkness, beginning in late April and extending through early July (Gustafson *et al.* 1997). After leaving the Puget Sound, sockeye move north to the Gulf of Alaska.

Maturity in sockeye salmon ranges from 3 to 8 years (Gustafson *et al.* 1997). Wydoski and Whitney (1979) report adult sockeye as reaching a length of 33 inches and a weight averaging between 3.5 and 8 pounds. Sockeye will spend 1-4 years in the ocean before returning to freshwater to spawn. Many adult sockeye make long migrations, requiring higher stored energy

reserves and any delay in migration, such as those caused by dams or low water levels, can be very damaging to spawning success (Hart 1988).

b. Known Occurrences in the Plan Area

Small numbers (less than 200) of sockeye adults have been observed spawning in the Green River below the Headworks (E. Warner 1998). It is unknown whether these are strays from Lake Washington habitat, or river type sockeye. Historically there has been no lake access in the Green River, so any lake-type sockeye were probably strays from other drainages. Although the origin of the Green River stock is unknown, between 1925 and 1931, at least 392,050 sockeye salmon fry derived from the Green River, Quinault Lake, and unspecified Alaska stocks were released into the Green River from the Green River State Hatchery (Gustafson *et al.* 1997). Peak counts of sockeye spawners in the Green River ranged from 1-16 fish during 14 years of surveys that occurred between 1954 and 1990. These fish were observed from mid-September to mid-November (Gustafson *et al.* 1997). Juvenile sockeye salmon were not among the five salmonid species captured during juvenile salmonid surveys on the middle Green River during 1998 (Jeanes and Hilgert 1999).

c. Population Status and Status under the ESA

Green River sockeye are classified as a riverine-spawning sockeye salmon under other population units by NMFS. Gustafson *et al.* (1997) states, "There was insufficient information (regarding riverine-spawning sockeye populations) to reach any conclusions regarding the status of this unit." There is no designated ESU for Green River sockeye salmon (see Table 1).

C. Critical Habitat

Critical habitat refers to the specific areas, both occupied and unoccupied, that contain those physical or biological features that are essential to the conservation of the species and which require special management considerations or protection (see ESA §3(5)(A)). Generally, critical habitat for anadromous salmonids is designated within specific geographies and includes those streams and riparian areas comprising the historic and/or longstanding distribution of the species.

Critical habitat for Puget Sound chinook has been designated (see Table 1). The proposed action, issuance of an ITP to the City of Tacoma, will likely affect criticial habitats within and potentially downstream of the Plan Area. The mechanisms through which critical habitats may be affected are primarily through water withdrawal from the Green River and through commercial forestry activities that affect ecological processes that maintain and create habitats for salmonids. Water withdrawal affects critical habitat by: 1) reducing juvenile and adult migration flows, 2) reducing adult spawning habitat area, and 3) by decreasing side-channel juvenile rearing habitat area and accessibility. Critical habitats are benefitted by increasing mainstem juvenile rearing area. Effects to critical habitat through forestry activities would be limited to the critical habitat in the Upper Green River, above HHD, and include: 1) riparian forest management that decreases large wood debris recruitment, shade, litter fall, and nutrients delivered to streams, and, 2) increased delivery of coarse and fine sediments to streams from mass-wasting of hillslopes and roads and the erosion and transport of sediments from road surfaces and ditchlines. Chapter 7 of the HCP (Tacoma 2001) provides a detailed assessment of the effects of covered activities and conservation measures on covered species and their habitats. Conservation measures to avoid, minimize and mitigate effects on designated critical habitats and habitat for all salmonids are described in Table 4 of this Opinion.

Habitat requirements for all anadromous salmonids include adequate substrate, water quality, water quantity, water temperature, water velocity, cover/shelter, food, riparian vegetation, space and safe passage conditions. Good summaries of the environmental parameters and freshwater factors that comprise critical habitats for Puget Sound chinook salmon, and other anadromous salmonids, can be found in: Barnhart 1986; Bjornn and Reiser 1991; Botkin *et al.* 1995; Brown and Moyle 1991; CACSST 1988; Groot and Margolis 1991; NRC 1996; NMFS status reviews (see Table 1 in this Opinion); Higgins *et al.* 1992; McEwan and Jackson 1996; Meehan 1991; Nehlsen *et al.* 1991; Pauley *et al.* 1986; Stouder et al. 1997; and Spence *et al.* 1996.

Defining specific river reaches that are critical for endangered or threatened anadromous fishes is difficult because of their low abundance and because of our limited understanding of the species current and historical freshwater distributions (63 Fed. Reg. 11510; March 9, 1998). Based on consideration of the best available information regarding the species current distribution, NMFS believes that the preferred approach to identifying the freshwater and estuarine portion of critical habitat is to designate all areas (and their adjacent riparian zones) accessible to the species within the range of each ESU (*Ibid*.).

The NMFS believes that adopting a more inclusive description of critical habitat is appropriate because it (1) recognizes the species' use of diverse habitats and underscores the need to account for all of the habitat types supporting the species' freshwater and estuarine life stages, from small headwater streams to migration corridors and estuarine rearing areas; (2) takes into account the natural variability in habitat use (e.g., some streams may have fish present only in years with plentiful rainfall) that makes precise mapping difficult; and (3) reinforces the important linkage between aquatic areas and adjacent riparian areas (*Ibid.*).

IV. ENVIRONMENTAL BASELINE

The environmental baseline for the anadromous salmonid species that inhabit the area covered by the HCP includes the past and present impacts of all Federal, State, or private activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process (50 CFR §402.02). Such actions include, but are not limited to, previous construction of water management facilities, river channel alterations, road construction, timber harvest, deforestation for agriculture, deforestation for urban/suburban development, and other land-use activities.

Populations of anadromous salmonids are at risk or already extinct in many river basins in Washington, leading to the numerous ESA listings and proposed listings for anadromous fish. These populations have declined due to a variety of human activities and natural events including hydropower development, overharvest, land management activities, artificial propagation, disease, predation, competition from introduced species, and climatic variation leading to temporarily unfavorable ocean conditions (see for example Busby *et al.* 1996, FEMAT 1993, Meyers *et al.* 1998, NRC 1996, Spence *et al.*, 1996).

The covered species analyzed in this Opinion are subjects of recent listing decisions by the NMFS referenced in Table 1. Prior to or following these listings, federal actions and effects on covered species have been assessed through: 1) management of National Forest system lands under the NW Forest Plan (FEMAT 1993), 2) development of a Habitat Conservation Plan by the Washington Department of Natural Resources and subsequent issuance of an Incidental Take Permit by NMFS (NMFS 1996), 3) development and modification of a Habitat Conservation Plan by Plum Creek Timber Company for exchange of lands with the USFS within the I-90 corridor (which includes lands in the Green River watershed) (PCT 1999), and, 4) operation and maintenance and the AWS project at Howard Hansen Dam by the USACE which includes an Incidental Take Statement covering Puget Sound chinook in the Green River (NMFS 2000). These consultations and the activities and effects to listed and unlisted species pertinent thereto, are briefly described below and are considered part of the baseline environmental condition for purposes of this Opinion. For each action described above, NMFS found that covered activities will not jeopardize the continued existence of one of more listed or unlisted species that are covered species in this Opinion.

Accordingly, this Biological Opinion addresses the environmental baseline reflecting the past and present impacts of previous and ongoing Federal (that have already undergone formal consultation), State, and private activities in the HCP area, for which there is adequate information. Sections 4.1 through 4.5 of the HCP (Tacoma 2001) and the Services' FEIS (USFWS and NMFS 2000) provide comprehensive descriptions of the baseline conditions in the action area.

The lower Green/Duwamish River basin is highly industrialized and urbanized. The river enters

Elliot Bay through the Port of Seattle. Over 90% of the estuary has been converted and modified in form and habitat function. The lower Green River is entirely channelized by levees to protected the commercially developed former flood plain. Most uplands suited to development have already been converted to commercial and residential uses. The Green River Gorge presents limited development opportunity and remains fair for spawning and good for juvenile fish rearing. The upper watershed is primarily in forestland management and is generally degraded from past management actions.

A. Non-federal Lands

At this time, most of the property surrounding the lower portion of Green River Watershed, below Tacoma's ownership, is privately held, and managed as commercial forest land, or is in some other land use, such as rural residential, or at the extreme lower end of Watershed, in urban and industrial land uses. Forest practices conducted on these lands are assumed to be conducted in compliance with Washington Forest Practices Regulations, as they exist currently, and as they will be amended in the foreseeable future (e.g. to conform to the April 1999 Forests and Fish Report). Land use conversions in the area surrounding the lower Watershed have been occurring at a rapid rate, and are expected to accelerate in the near term. It is assumed that development activities will be in compliance with King County's Growth Management Plan (King County 1998) and Critical Areas Ordinances, as they exist currently, and as they will be amended in the future, including the proposed year 2000 amendments that are specifically designed to respond to the listing of salmon and bull trout under the Act.

Non-Federal forest lands within and adjacent to the Plan Area come under the regulation of Washington Forest Practice Rules. These Rules have recently undergone revisions and have been finalized by the Washington Forest Practices Board to protect salmon and bull trout, including Puget Sound chinook salmon. This Salmonid Emergency Rule immediately increased riparian conservation measures along fish-bearing streams and limits sediment delivering activities, among many other facets. Most recently, the State of Washington, Federal Agencies, County governments, tribal governments reached agreement on a comprehensive set of conservation measures upon which to revise Washington Forest Practice Rules (the "Forests and Fish Report" (FFR), available from the Washington Department of Natural Resources, Olympia, WA). These new protections are described by the Governor's Salmon Recovery Office (State of Washington 1999). While it will take some time for the benefits of new forest practices to accrue, the effects will complement watershed management and overall function of riparian and instream habitats to the extent that these new forest practices will apply within and adjacent to the Plan Area.

B. Washington Department of Natural Resources Lands

An important consideration in baseline conditions are approximately 20, 700 acres of lands in the Upper Green River watershed that managed by the Washington Department of Natural Resources (WDNR) under an existing HCP (WDNR 1997). The WDNR Plan and associated Implementing Agreement and Incidental Take Permit cover forestry and other activities that may affect listed anadromous salmonids and their habitats. The WDNR HCP utilizes a suite of conservation measures that are expected to minimize take of anadromous fishes. The NMFS has consulted on this HCP and issued a Biological Opinion which found that activities, in accord with that HCP, associated documents, and as adapted, would not jeopardize the continued existence of then-proposed or listed species. Multiple ESUs within the WDNR Plan Area have now been listed under the ESA and the NMFS has issued an Incidental Take Permit to the WDNR for six salmon ESUs, including Puget Sound chinook (June 14, 1999 Memorandum from S.W. Landino to W. Stelle, Jr.; Biological Opinion and Section 10 Findings Document for Washington Department of Natural Resources Habitat Conservation Plan Incidental Take Permit 1168; on file at the NMFS, WSHB offices, Lacey, WA). However, that action, Permit issuance, will not change the commitments and conservation measures described in detail in the WDNR HCP (WDNR 1997).

C. Federal Lands (U.S. Forest Service)

At the landscape level, the effects of current forest and watershed management activities by the USFS is a consideration that has been addressed by the NMFS through participation in the development of, and formal participation on Federal actions under the Northwest Forest Plan (FEMAT 1993). Future federal actions that bring new lands under USFS management, change land allocations or management designations, or impact habitats for listed anadromous fishes will be addressed in separate formal consultations.

The NMFS considered the effects of USFS management of lands acquired through a recent exchange with Plum Creek Timber company (discussed below). The USFS currently manages approximately 31,000 acres in the Upper Green River watershed. Overall, NMFS found that the location of these lands in the Green River watershed was such that limited effects on listed or unlisted species is expected, particularly considering the conservative management that must occur under the NW Forest Plan (FEMAT 1993).

D. Plum Creek Timber Lands

Plum Creek Timber owns and manages approximately 53, 300 acres in the Upper Green River watershed. The NMFS reviewed Plum Creek lands in the Green River watershed in 1999 in consultation on the action of the Services to approve the modification of the Plum Creek Timber, Cascades Habitat Conservation Plan (PCT 1996). The focus of NMFS analysis of effects was on lands within the Plan Area being exchanged from Plum Creek Timber to the United States and being removed from coverage by under an ITP; and those lands exchanged from the United States to Plum Creek Timber being added to covered for Incidental Take.

Exchanged lands were, and continue to be, managed under either the Plum Creek HCP or by the USFS under the Northwest Forest Plan, both of which have undergone extensive review and approval under the National Environmental Policy Act (NEPA) and Section 7 of the ESA. These include: 1) NMFS Unlisted Species Analysis and Findings (NMFS 1996) based on information provided in the Multi-Species Habitat Conservation Plan on Forest lands owned by Plum Creek Timber Company, L.P., in the I-90 Corridor of the Central Cascades Mountain Range, Washington (PCT 1996), 2) the Final Environmental Impact Statement for the Proposed Issuance of a Permit to Allow Incidental Take of Threatened and Endangered Species: Plum Creek Timber Company, L.P., Lands in the I-90 Corridor, King and Kittitas Counties, Washington (USDI and USDC 1996), 3) the Implementation Agreement for the Plum Creek Timber Company, L.P., Multi-species Habitat Conservation Plan (PCT *et al.* 1996), 4) 13 technical papers prepared in support of the HCP, and, 5) various other documents cited in the NMFS (1996). The principle change resulting from the I-90 Land Exchange is the new land base to which the HCP will apply, and the new land base to which the Northwest Forest Plan will apply. Some minor changes were made within the HCP as a result of, and consistent with, the new land base. The HCP modification document (PCT 1999) addresses revisions in the baseline that have occurred since the FWS issued an ITP to Plum Creek Timber in 1996, and provides a description of impacts anticipated as a result of the modified land-base and associated changes to the HCP.

In the Green River drainage, the net change in conservation benefit for Puget Sound Chinook salmon was difficult to establish because the exchanged lands include little stream mileage (less than seven miles in total). The NMFS expects that there may be some change in overall watershed function by managing a slightly different spatial arrangement under the HCP. Plum Creek Timber will bring about 2,000 acres of additional lands in this watershed under management of the HCP, consolidating their ownership along the eastside of the mainstem of Sawmill Creek, a fish-bearing tributary (the USFS would have continuous ownership along the westside of Sawmill Creek). Some, unquantifiable change in riparian functions (particularly the recruitment of large woody debris) and the production and delivery of sediments to aquatic habitats can be expected. However, there should be benefits that accrue through newly acquired National Forest lands and management under the Northwest Forest Plan. Additionally, land management prescriptions developed by Plum Creek Timber through watershed analysis will supplement and adapt conservation measures in the HCP, particularly with respect to road management, unstable slopes and delivery of sediments to aquatic habitats. Overall, NMFS found (NMFS 1999) that, the net effect of the land exchange and continued management of lands by the USFS and Plum Creek is likely to continue to provide incremental progress towards proper functioning conditions of aquatic habitats within the Upper Green Watershed.

E. USACE Operation and Maintenance of Howard Hanson Dam

The Corps consulted with NMFS regarding potential effects of HHD operations and the proposed AWS project. NMFS Biological Opinion from that consultation addresses ongoing maintenance and operations at the project. Not yet addressed, but scheduled in that Opinion, is the routing of sediment through the project. A sediment routing or management plan is scheduled for submission to NMFS by October 2002. The consultation also addressed the AWS project. Additional water storage provides water for Tacoma's M&I needs and also increases the supply of stored water that will become available to augment streamflow to benefit listed and unlisted fish species in the middle and lower Green River.

F. Limiting Factors in the Action Area

The Green River is one of three historic primary hydrologic units tributary to the Duwamish River and Elliot Bay. The White River has changed course many times historically and formerly joined the Green River near the town of Auburn but changed its course to become a tributary of the Puyallup River in about 1908. Development has fixed the location. The Green River joined the Black River, the historic outlet of the Lake Washington drainage, between Renton and Tukwila, forming the Duwamish River. The lowering of Lake Washington disconnected most of the Black River drainage from the Duwamish system. A portion of that drainage into the Duwamish is maintained by a pump station. The present day Green River transitions into the Duwamish near Tukwila with little notice in the aquatic landscape.

Chinook habitat in the Green River is adversely affected by numerous factors from Elliot Bay to the ridge crests of the upper river basin. Those factors include urban and industrial development within Elliot Bay and the Duwamish River estuary that decrease and degrade critical juvenile chinook habitat, leaving less than 10% of the historic abundance of that habitat type. The Duwamish and lower Green River are diked and levied nearly continuously to points upstream of Auburn, disconnecting the flood plain, constricting the river channel and side channels from habitat forming and maintenance opportunities. The result is a reduction in both the quantity and quality of spawning and rearing habitat. The lower valley and estuarine wetlands have been drained and filled for agricultural and urban development. Road building and forest practices have contributed to higher rates of sedimentation in stream gravels. Blockages by water diversions and dams and shifts in the flow regime have affected habitat range, quantity, and quality. The dams have reduced the supply of coarse sediment that maintains spawning habitat, particularly in the steeper gradient downstream reach. They have likewise reduced the supply of large woody debris (LWD) to the lower river.

The Green River upstream of Howard Hanson Dam retains good potential habitat function for chinook salmon spawning and rearing if passage and access problems are addressed. Stream flows upstream of HHD reservoir are unaffected by the project and differ from pre-project conditions only through the effects of timber harvesting and road building in the watershed. Seasonal low flows are expected to be somewhat exacerbated, and fine sediment concentrations in spawning gravels elevated and frequency of large volume pools reduced. These conditions would still be expected to fall well within the range of productive chinook salmon habitat.

G. Summary of Species' Status

1. <u>Chinook Salmon (Puget Sound ESU)</u>

This ESU is inclusive of all Hood Canal and Puget Sound rivers and independent tributaries, including some in the eastern Strait of Juan de Fuca. Overall, abundance of chinook salmon in the Puget Sound ESU has declined substantially, and both long- and short-term abundance trends are predominantly downward. These factors have led to the listing of the Puget Sound ESU as threatened under the ESA on 26 February 1998 (63 Fed. Reg. 11482). Sedimentation and high water temperatures are major habitat problems faced by chinook in the Green River (Myers *et al.* 1998), even though the Green River and Newaukum Creek stocks are listed as healthy by the Washington Department of Fish and Wildlife (WDFW et al. 1994). The Green River and Newaukum Creek stocks were two of the six mixed-origin stocks (out of 28 stocks located in the Puget Sound ESU) that were listed as healthy by the Washington Department of Fish and Wildlife (Meyers *et al.* 1998).

A Genetic Stock Inventory (GSI) sample of various parts of the river was conducted in the fall of 1997, and this sample will be analyzed to determine what parts of the Green River population may still contain segments of wild Green River chinook salmon. This analysis could be important in establishing the final assessment of the stock as wild, wild and hatchery, or hatchery, and could affect chinook protection and recovery if listed as a threatened species (Myers *et al.* 1998).

2. <u>Coho Salmon (Puget Sound / Strait of Georgia ESU)</u>

The coho salmon is considered to be the most numerous anadromous fish in the Green/Duwamish basin (King County Planning Division 1978). Two coho stocks have been identified in the Green River Basin, the Green River/Soos Creek, and Newaukum Creek (WDFW et al. 1994). The Green River/Soos Creek stock is of mixed origin. Releases of both native and non-native hatchery-origin coho in this system dates back to the early 1950s. Currently, approximately 3 million yearling coho are released annually from hatchery facilities located on Soos and Crisp creeks. Natural reproduction in Soos Creek is derived from hatchery-origin adults passed above the rack. Production upstream of HHD is derived from off-station fry and fingerling releases. Escapement data for the Green River/Soos Creek coho stock are limited, however run reconstruction data indicates stable escapement and the stock is considered healthy (WDFW *et al.* 1994).

Green River/Soos Creek coho population data indicates stable escapement and production levels, however, the last year of data analyzed (1991) is the lowest in database history, and similar values in the future would quickly bring this stock into the "depressed" category (WDFW *et al.* 1994).

The Newaukum Creek coho stock has experienced short-term severe decline in population that has been limited by summer low flows (WDFW *et al.* 1994). This stock is currently designated depressed status by WDFW *et al.* (1994). Green River coho stocks were placed in the Puget Sound/Strait of Georgia ESU. Continued loss of habitat, extremely high harvest rates, and a severe recent decline in average spawner size are substantial threats to remaining native coho populations in this ESU. Currently, this ESU is not listed as threatened or endangered. However, because of limited information on many coho stocks in this ESU and risks to naturally producing populations, the Puget Sound/Strait of Georgia ESU was added to the list of candidates for threatened and endangered species. If present trends continue, this ESU is likely to become endangered in the foreseeable future (Weitkamp *et al.* 1995).

3. <u>Chum Salmon (Puget Sound / Strait of Georgia ESU)</u>

Green River chum salmon are included in the Puget Sound/Strait of Georgia ESU. Commercial harvest of chum salmon has been increasing since the early 1970s throughout this ESU. This increased harvest, coupled with generally increasing trends in spawning escapement, provides compelling evidence that chum salmon are abundant and have been increasing in abundance in recent years within this ESU (Johnson *et al.* 1997). The National Marine Fisheries Service concluded that this ESU is not presently at risk of extinction, and is not likely to become endangered in the near future (63 Fed. Reg. 11778).

4. <u>Pink salmon (Odd year ESU)</u>

Washington and southern British Columbia pink salmon stocks, divided into even- and odd-year ESUs, are not considered warranted for listing at this time. No even-year pink salmon populations occur within the action area, or are thought to have been historically present. Hard *et al.* (1996) reviewed the status of pink salmon and note that several Pacific Northwest streams have experienced depressed pink salmon runs in recent years. Prior to the 1930s, odd-year pink salmon were present in the Green River (Grette and Salo 1986). However, for the most part, they have been eliminated from the river system.

5. <u>Sockeye salmon</u>

Green River sockeye are classified as a riverine-spawning sockeye salmon under other population units by NMFS. Gustafson *et al.* (1997) states, "There was insufficient information (regarding riverine-spawning sockeye populations) to reach any conclusions regarding the status of this unit."

6. <u>Steelhead trout (Puget Sound ESU)</u>

Green River steelhead have been classified as part of the Puget Sound ESU (1 of 15 west coast steelhead ESU's). Natural fish (wild runs) are the focus of ESU determinations. In the Green River system, the wild winter steelhead population is a distinct stock based on geographic isolation of the spawning population (WDFW *et al.* 1994). Escapement goals have been approximately met or exceeded during 5 of the seasons between 1985 and 1992.

Overall, the status of Green River steelhead populations are considered healthy (WDFW *et al.* 1994). However, there has been a general decline in recent (within the past few years) steelhead populations throughout the Strait of Juan de Fuca, Pacific coast, and Columbia River. NMFS review indicated that, in general, the entire Puget Sound ESU is not threatened at this time. However, future population declines may warrant changes in ESA status (Busby *et al.* 1996).

V. ELEMENTS OF THE HABITAT CONSERVATION PLAN

A. Overall Goal of the HCP

The overall goal of the Tacoma's HCP is to provide a continuing, consistent water supply to its customers and to avoid, minimize and mitigate the effects of Tacoma's actions on listed and unlisted species and their habitats to the maximum extent practicable.

B. Proposed Conservation Measures to Avoid, Minimize, and Mitigate Take.

A suite of measures are proposed in the HCP that collectively contribute to protection and restoration of the species and habitats addressed by this action. These measures were designed to control, avoid, or minimize impacts from commercial forest operations, to preserve habitat elements that are relatively undisturbed, and to passively or experimentally restore the quality and functionality of habitats that have been previously disturbed.

Tacoma's habitat conservation measures and stewardship actions are listed in Table 4, below.. Because a number of the measures have been jointly sponsored by Tacoma and other parties, the measures can be divided into three types, depending on their focus and where and how benefits are directed:

- Implementation of measures designed to offset or compensate for impacts resulting from a Tacoma water withdrawal action (e.g., withdrawal of water under SDWR) – designated Type 1 measures;

- Contribution of funds and/or implementation of measures designed to offset or compensate for impacts resulting from a non-Tacoma action (e.g., financial support of gravel nourishment measures to offset effects of HHD flood control) – designated Type 2 measures; and

- Implementation of mitigation/restoration measures in the Green River watershed designed to offset impacts of Tacoma non-water withdrawal activities (e.g., forestry operations in the upper watershed) – designated Type 3 measures.

Type 1 habitat conservation measures are those designed to offset or compensate for impacts resulting from Tacoma water withdrawal activities. For instance, as part of the MIT/TPU Agreement, Tacoma agreed to design, construct, and operate an upstream fish passage facility at its Headworks, the Green River municipal and industrial water supply intake located at RM 61.0. The upstream fish passage facility was one of several measures that were developed as part of the MIT/TPU Agreement that settles Muckleshoot claims against Tacoma, including the FDWRC and the SDWR, arising out of Tacoma's municipal water supply operations on the Green River. Selected excerpts of the 1995 MIT/TPU Agreement are provided in HCP

Appendix B (Tacoma 2001).

Type 2 habitat conservation measures are those designed to offset or compensate for impacts resulting from activities carried out by parties other than Tacoma but for which Tacoma is providing a portion of the funding. For instance, construction and operation of HHD for Green River flood control has interrupted the transport of gravel-sized and larger sediments. Construction and operation of HHD is a USACE activity; however, as local sponsor of the AWS project, Tacoma is providing funds to place gravels in the middle Green River channel.

Habitat conservation measures defined as Type 3 are designed to offset Tacoma activities not associated with the operation of Tacoma's water supply system on the Green River, but that have been proposed as a mitigation activity within the HCP area. Table 4 describes each Habitat Conservation Measure (HCM) by title, type (1,2 or 3) and USACE AWS project number, as applicable.

Table 4. Tacoma Green River Water Supply habitat conservation measures to be implemented under the HCP.

Habitat Conservation Measure	Title	Description	Type of Measure[1]	U.S. Army Corps of Engineers AWS Project Number [2]
HCM 1-01	FDWRC Instream Flow Commitment	Guaranteed continuous flow maintained at Auburn, WA gage (stipulated in the MIT/TPU Agreement)	Type 1	N.A.
HCM 1-02	Seasonal Restrictions on SDWR	Minimum flow restrictions on SDWR withdrawals at Auburn and Palmer, WA gages (stipulated in the MIT/TPU Agreement)	Type 1	N.A.
HCM 1-03	Tacoma Headworks Upstream Fish Passage Facility	Construction/operation of upstream fish passage facility at Headworks	Type 1	N.A.
HCM 1-04	Tacoma Headworks Downstream Fish Bypass Facility	Installation of screen and fish bypass facility at Headworks	Type 1	N.A.
HCM 1-05	Tacoma Headworks Large Woody Debris (LWD)/Rootwad Placement	Installation of LWD, rootwads and boulders to enhance rearing capacity in Headworks inundation pool	Type 1	N.A.
HCM 2-01	HHD Downstream Fish Passage Facility	Construction/operation of downstream fish passage facility at HHD	Type 2	Mitigation and Restoration FP-A8

Habitat Conservation Measure	Title	Description	Type of Measure[1]	U.S. Army Corps of Engineers AWS Project Number [2]
HCM 2-02	HHD Non-Dedicated Storage and Flow Management Strategy	Provide opportunity to manage springtime water storage and release at HHD to minimize impacts to salmonids	Type 2	N.A.
HCM 2-03	Upper Watershed Stream, Wetland, and Reservoir Shoreline Rehabilitation Measures	Rehabilitate fish and wildlife habitat in the reservoir inundation zone, riparian areas upstream and downstream of HHD	Type 2	Mitigation and Restoration MS-02, 04, 08 TR-01, 04, 05, 09 VF-05
HCM 2-04	Standing Timber Retention	Retention of 166 acres of deciduous, 48 acres mixed, and 15 acres of conifer forest in the HHD pool inundation zone	Type 2	N.A.
HCM 2-05	Juvenile Salmonid Transport and Release	Transport and release of juvenile salmonids above HHD if determined to be beneficial	Type 2	N.A.
HCM 2-06	Low Flow Augmentation	Option to provide an additional 5,000 ac-ft of water for low flow augmentation	Type 2	USACE 1135
HCM 2-07	Side Channel Re-connection Signani Slough	Re-connect and rehabilitate 3.4 acres of off-channel habitat in Signani Slough (RM 60)	Type 2	Restoration VF-04
HCM 2-08	Downstream Woody Debris Management Program	Introduce woody debris into Green River downstream of Headworks	Type 2	Restoration MS-09
HCM 2-09	Mainstem Gravel Nourishment	Provide up to 3,900 yd3 gravel into Green River downstream of Headworks	Type 2	Restoration LMS-01, 02, 03, 04
HCM 2-10	Headwater Stream Rehabilitation	Creation of off-channel habitat, installation of LWD/rootwads in Green River, N F Green River, and eight tributaries	Type 2	Restoration MS-03 TR-06, 07
HCM 2-11	Snowpack and Precipitation Monitoring	Install up to three snow pillows in the upper Green River basin	Type 2	N.A.
HCM 3-01 — UPLAND FOREST MANAGEMENT MEASURES				
HCM 3-01A	Upland Forest Management Measures	Management of Tacoma lands within the HCP according to natural, conservation, or commercial designations	Type 3	N.A.

HCM 3-01B	Natural Zone	No timber harvesting except to modify fish or wildlife habitat or remove danger trees along roads	Type 3	N.A.
HCM 3-01C	Conservation Zone	No even-aged harvesting in conifer-dominated stands and no harvesting (except danger tree removal along roads and fish and wildlife habitat modifications) in conifer-dominated stands older than 100 years	Type 3	N.A.
HCM 3-01D	Commercial Zone	Coniferous forests will be managed on an even-aged rotation of 70 years	Type 3	N.A.
HCM 3-01E	Hardwood Conversion	Stands in the conservation and commercial zones dominated by hardwood on sites capable of producing conifers may be converted to conifers by clearcutting	Type 3	N.A.
HCM 3-01F	Salvage Harvesting	Salvage timber harvesting only in forested areas of the Commercial Zone and stands in the Conservation Zone under 100 years old affected by wind-throw, insect infestation, disease, flood or fire according to set prescriptions	Type 3	N.A.
HCM 3-01G	Snags, Green Recruitment Trees and Logs	Tacoma will retain all safe snags and at least four green recruitment trees and four logs per acre, where available	Type 3	N.A.
HCM 3-01H	Harvest Unit Size	Even-aged harvest units will not exceed 40 acres in size	Type 3	N.A.
HCM 3-01I	Even-aged Harvest Unit Adjacency Rule	Even-aged harvesting will occur when the surrounding forest land is fully stocked with trees a minimum of 5 years old and 5 feet high	Type 3	N.A.
HCM 3-01J	Harvest Restrictions on sites with Low Productivity	Timber harvesting will occur only on lands with a Douglas-fir 50-year site index of greater than 80	Type 3	N.A.
HCM 3-01K	Contractor and Logger Awareness	Contractor, loggers, and forestry workers operating in the Upper HCP Area will be required to comply with relevant HCP measures	Type 3	N.A.
HCM 3-01L	Logging Slash Disposal	Slash disposal will not be burned unless burning is part of habitat modification	Type 3	N.A.
HCM 3-01M	Reforestation	All even-aged stands will be re-planted with 300-400 suitable trees per acre by the first spring following harvest	Type 3	N.A.

HCM 3-01N	Harvest on Unstable Slopes	Tacoma will identify potentially unstable landforms and apply general prescriptions developed by Watershed Analysis or site-specific prescriptions developed by a slope stability specialist	Type 3	N.A.
HCM 3-02 — RIPARIAN MANAGEMENT MEASURES				
HCM 3-02A	No-Harvest Riparian Buffers	Tacoma will retain no-harvest buffers along all streams and wetlands in the Upper HCP Area	Type 3	N.A.
HCM 3-02B	Partial Harvest Riparian Buffers	Tacoma will retain partial-harvest riparian buffers outside no-harvest buffers on Type 3 and Type 5 streams	Type 3	N.A.
HCM 3-03 — ROAD CONSTRUCTION AND MAINTENANCE MEASURES				
HCM 3-03A	Watershed Analysis	Tacoma will participate in all Watershed Analyses performed according to the WFPB within the HCP area	Type 3	N.A.
HCM 3-03B	Road Maintenance	Tacoma participate in the development of a Road Sediment Reduction Plan describing the priorities and schedule for road maintenance, improvement and abandonment activities that will be implemented to reduce road sediment inputs.	Type 3	N.A.
HCM 3-03C	Roads Construction on Unstable Landforms	Tacoma will implement all draft and final mass wasting prescriptions specific to new road construction in WAUs where watershed analyses are approved or pending. In WAUs where assessments have not been completed within 2 years following issuance of the ITP, Tacoma will complete a slope stability analysis and develop site-specific prescription for road construction.	Type 3	N.A.
HCM 3-03D	Roads on Side Slopes Greater Than 60 Percent	Tacoma will use full bench construction with no side casting of excavated materials on side slopes greater than 60 percent	Type 3	N.A.
HCM 3-03E	Erosion Control	Tacoma will place mulch and/or grass seed on all road cuts and fills with slopes over 40 percent or near water crossings as well as in areas of severe erosion/slumping danger or above and below roads	Type 3	N.A.

HCM 3-03F	Stream Crossings	When constructing roads through riparian areas, Tacoma will minimize right-of-way clearing, cross streams at right angles, minimize stream disturbances and side-casting of excavated materials, and provide for upstream and downstream passage in fish-bearing streams	Type 3	N.A.
HCM 3-03G	Road Closures	Tacoma will maintain a locked gate to restrict road use except where the USFS requires roads to be open	Type 3	N.A.
HCM 3-03H	Roadside Vegetation	Tacoma will maintain low-growing vegetation along roads to stabilize soils and minimize erosion	Type 3	N.A.
HCM 3-03I	Road Abandonment	Tacoma will abandon roads in the HCP area that are no longer needed for watershed management, forestry operations, or HCP implementation according to a specified schedule	Type 3	N.A.
HCM 3-03J	Culvert Improvements	Tacoma will inventory all roads in the HCP area and identify all culverts that block fish passage within 1 year of issuance of ITP, plans to eliminate blockages will be made within 2 years, and all blockages will be eliminated within 5 years of issuance of an ITP	Type 3	N.A.
HCM 3-04 — SPECIES SPECIFIC MANAGEMENT MEASURES				
HCM 3-04A through HCM 3-04AX	Measures specific to terrestrial and aquatic species under the authority of the USFWS (see USFWS 2001)	These measures are not considered in this Opinion. See Table 5-1 in Tacoma (2001) for a complete description.	Type 3	N.A.

1 Type 1: Protection measure designed to offset impacts of a Tacoma water withdrawal activity.
Type 2: Protection measure designed to offset impacts of a non-Tacoma activity.
Type 3: Protection measures designed to offset impacts of a Tacoma non-water withdrawal activity.
2 Project numbers refer to mitigation and restoration measures identified in the Draft Environmental Impact Statement (DEIS) for the Additional Water Storage Project (USACE 1998). Note that during further development of the measures, site designations may change from those identified in the DEIS.

VI. ANALYSIS OF EFFECTS

A. Evaluating the Proposed Action

The purpose of interagency consultation under Section 7 of the ESA is to ensure that Federal actions will not jeopardize the continued existence of listed species or adversely modify or destroy critical habitat. The Federal action that is the subject of this Biological Opinion is NMFS' issuance of an Incidental Take Permit to Tacoma Water. For actions that cover permits of long duration, such as Incidental Take Permits, the ability of NMFS to specifically identify effects such as the death or injury of individual fish is limited. Therefore, the analysis of effects on covered species is achieved by analyzing the effects on ecological processes that covered species rely on, including effects on designated critical habitats.

The NMFS must determine whether the action is likely to jeopardize the listed species and/or whether the action is likely to destroy or adversely modify critical habitat. This analysis involves the initial steps of (1) defining the biological requirements and current status of the listed species, and (2) evaluating the relevance of the environmental baseline in the action area to the species' current status throughout the listed ESU. Biological requirements and covered species status are presented in Sections III and IV of this Opinion. The standards for determining jeopardy are set forth in section 7(a)(2) of the ESA as defined by 50 C.F.R. Part 402 (the consultation regulations).

Subsequently, NMFS evaluates whether the action is likely to jeopardize the listed species by determining if the species can be expected to survive with an adequate potential for recovery. In making this determination, NMFS must consider the estimated level of mortality attributable to: (1) collective effects of the proposed or continuing action, (2) the environmental baseline, and (3) any cumulative effects. This evaluation must take into account measures for survival and recovery specific to the listed salmon's life stages that occur beyond the action area. If NMFS finds that the action is likely to jeopardize, NMFS must identify any reasonable and prudent alternatives for the action that are likely to avoid jeopardizing the species.

The following analysis examines the effects by species, by life history stage, and by river reach, of the activities associated with water withdrawal by Tacoma and management of Tacoma's lands in the upper Green River watershed. This analysis is organized as presented in the HCP (Tacoma 2001) through an examination of the species occurring by river reach, the effects of covered activities on each species life stage and habitat, and the effects of covered activities on the conservation and recovery of habitats and the processes that create them. Tacoma is requesting an Incidental Take Permit for two distinct sets of activities associated with procurement of water from the Green River: 1) the withdrawal of water under the First Diversion Water Right Claim (FDWRC), the Second Diversion Water Right (SDWR), and effects of springtime storage of the SDWR on downstream resources, and 2) the management of the upper Green River watershed above the Headworks. A mix of qualitative and quantitative information is available to analyze effects. Mostly qualitative information is available about the effects to fish from the upper watershed management activities. And since Tacoma holds only about 10% of that land, the estimated net effect to covered species is necessarily qualitative. Quantitative information was used to estimate the effects to fish of some of the conservation measures, and qualitative was frequently used to estimate effects to habitat, with the actual outcome to covered fish being less certain. Consequently, the effects analysis is a mix of quantitative and qualitative analysis.

The analysis describes potential increases and decreases in mortality of fish and to habitat quantity from the various measures. The benefits to steelhead and coho are likely to be the most profound, through the provision of upstream and downstream fish passage to the upper watershed. The potential benefit to chinook is more speculative because the use of the proposed juvenile passage facilities is much less certain for this species. Considered collectively, the measures are not anticipated as being adverse for chinook; rather, they are expected to be very good for the other species.

Covered activities have been analyzed for their general environmental and species-specific effects in the FEIS prepared by the Services (USFWS and NMFS 2000), the HCP prepared by Tacoma in collaboration with the Services (Tacoma 2001), and in the PBA prepared by the USACE (USACE 2000). These analyses are incorporated herein by reference and listed in the following table. Taken as a whole, these and other analyses listed below are the best available science used in the preparation of this Opinion. Table 5 lists analyses by covered activity and source document.

Table 5. Tacoma Water activities proposed for coverage under an Incidental Take Permit and source documents describing the effects of those activities on species to be covered under an Incidental Take Permit.

Covered Activities	Source document describing effects of activities
Water withdrawal at Tacoma's Headworks (associated with First Diversion Water Right claim and Second Diversion Water Right)	Tacoma Water HCP subsection 5.1.1 and 5.1.2; HCP Chapter 7 Impact Analysis Procedures; and HCP Chapter 7 species-specific subsections titled "Middle and Lower Watershed – Potential effects of covered activities and conservation measures" FEIS-ITP, Section 4.0 Environmental Consequences, subsection 4.2 Water Withdrawal Alternatives
Water withdrawal from the North Fork Well Field (associated with First Diversion Water Right claim)	Tacoma Water HCP subsection 5.1.1, and HCP Chapter 7 under species-specific subsections titled "Upper Watershed – Potential effects of covered activities and conservation measures" FEIS-ITP, Section 4.0 Environmental Consequences, subsection 4.2 Water Withdrawal Alternatives
Construction of Headworks improvements	Tacoma Water HCP subsection 5.1.3, and HCP Chapter 7 under species-specific subsections titled "Middle Watershed – Potential effects of covered activities and conservation measures" FEIS-Second Supply Project, subsection 5.0 Proposed Action (Merry 1994) Second Supply Project – Biological Assessment, Subsection 4.2.3 Effects of the Action (Beak 1996)

Table 5. Tacoma Water activities proposed for coverage under an Incidental Take Permit and source documents describing the effects of those activities on species to be covered under an Incidental Take Permit.

Covered Activities	Source document describing effects of activities
Operation of the downstream fish bypass facility at the Headworks	Tacoma Water HCP subsection 5.1.4, and HCP Chapter 7 under species-specific subsections titled "Middle Watershed – Potential effects of covered activities and conservation measures" FEIS-Second Supply Project, subsection 5.0 Proposed Action (Merry 1994) Second Supply Project – Biological Assessment, Subsection 4.2.3 Effects of the Action (Beak 1996)
Tacoma Water watershed forest management	Tacoma Water HCP; Chapter 7 under species-specific subsections titled "Upper Watershed-Watershed Management" Green River Watershed Forest Land Management Plan (Ryan 1996) FEIS-ITP, Section 4.0 Environmental Consequences, subsection 4.3 Upper Watershed Alternatives
Monitoring of downstream fish passage through the HHD reservoir and fish passage facility	Tacoma Water HCP, Chapter 6 DEIS-AWSP, Appendix F1, subsection 10.A (USACE 1998) FEIS-ITP, Section 4.0 Environmental Consequences, subsection 4.2 Water Withdrawal Alternatives
Monitoring and maintenance of AWSP fish habitat restoration projects and AWSP fish and wildlife habitat mitigation projects	Tacoma Water HCP, Chapter 6 DEIS-AWSP, Appendix F1, subsection 10.E; Appendix F2, subsection 5 (USACE 1998) FEIS-ITP, Section 4.0 Environmental Consequences
Potential restoration of anadromous fish above HHD; including upstream transport of adults returning to the Headworks; and possible planting of hatchery juveniles above HHD if found to be beneficial to restoration.[1]	Tacoma Water HCP subsection 5.2.3, and HCP Chapter 7 under species-specific subsections titled "Upper Watershed – Potential effects of covered activities and conservation measures" DEIS-AWSP, Appendix F1, subsection 2.A and 2.B.5 (USACE 1998)
Implementation, monitoring and maintenance of species-specific management measures	Tacoma Water HCP subsection 5.3.4, and HCP Chapter 7 under species-specific subsections FEIS-ITP, Section 4.0 Environmental Consequences, subsection 4.3.7 Water Withdrawal Alternatives, Wildlife

1. Note: The Muckleshoot Fish Restoration Facility, which is supported by Tacoma, will proceed through the necessary Tribal, federal and state regulatory process separate from the Incidental Take Permit, should an Incidental Take Permit be issued to Tacoma Water.

AWSP (AWS): consistency Additional Water Storage Project
DEIS: Draft Environmental Impact Statement
FEIS: Final Environmental Impact Statement
HCP: Habitat Conservation Plan
HHD: Howard Hanson Dam
ITP: Incidental Take Permit
USACE: U.S. Army Corps of Engineers

While Tacoma Water is the local sponsor for the AWSP, the USACE will be the lead federal agency. As a federal action, the Incidental Take Permit that Tacoma is requesting under Section 10 of the ESA cannot cover the AWSP. Consequently, the effects of the AWSP are addressed in the USACE's Draft Feasibility Report and DEIS (USACE 1998) and are not analyzed in Tacoma Water's HCP. An Incidental Take Statement for the AWSP was secured by the USACE through the consultation process prescribed in Section 7 of the ESA. The USACE submitted a Programmatic Biological Assessment to the Services in April 2000. Following consultation, the Services issued an Incidental Take Statement addressing the AWSP in a Biological Opinion in October 2000.

B. Conservation Measures

Tacoma receives a majority of its water supply from the Green River. Water is diverted from the Green River for municipal and industrial (M&I) use at the Tacoma Water Supply Intake at RM 61.0 (Headworks) or at the North Fork well field in the upper watershed. Water withdrawals reduce flows in the reaches downstream of these locations, affecting the availability and quality of habitat for a variety of aquatic and terrestrial species. The Headworks diversion structure also presents a barrier to the upstream migration of anadromous fish, which directly affects adult salmon and steelhead returning to spawn in the river above RM 61.0. Blocking the upstream migration of anadromous fish indirectly affects a variety of fish and wildlife species due to the loss of marine-derived nutrients. Most adult anadromous fish die after spawning, and their carcasses play an important role in the nutrient cycle of Pacific Northwest watersheds.
Tacoma is proposing a number of flow-related conservation measures, non-flow-related measures and habitat-rehabilitation measures to mitigate these impacts. Some of these measures were developed in cooperation with the USACE in response to a letter identifying six principles of operation and design regarding the Howard Hanson Dam, Additional Water Storage project (AWS project) (see Appendix E). Tacoma is also providing additional funding support[1] for measures to improve fish and wildlife resources in areas of the Green River watershed where habitat conditions have been degraded by the management activities of others (e.g., diking of lower river for flood control, reduction in gravel transport by Howard Hanson Dam [HHD]).

[1] The cost-share percentages referenced in this document between Tacoma and the U.S. Army Corps of Engineers (USACE) are subject to changes in the Water Resource Development Act or other congressional funding initiatives that may adjust the cost-share formula between the parties.

The conservation measures summarized here are described in more detail in Chapter 5 of the HCP.

Tacoma's flow-related conservation measures are listed and detailed in Chapter 5 of the HCP.

1. Minimum Flow Requirements

The minimum instream flows provided under the Muckleshoot Indian Tribe/Tacoma Public Utilities Agreement (MIT/TPU Agreement) address habitat conditions for fish and wildlife habitat resources in the lower and middle Green River during the summer and fall. The lowest flows allowed in the Green River at Auburn under the provisions of the MIT/TPU Agreement are 225 to 250 cubic feet per second (cfs) during drought years, 250 cfs during average to dry years, 300 cfs during wet to average years, and 350 cfs during wet years. Tacoma's SDWR on the Green River was originally limited only by state of Washington-imposed instream flows at the Palmer U.S. Geological Survey (USGS) river gage. The State places no minimum flow restriction on the FDWRC, and requires 200 to 300 cfs under the SDWR. Constraints on use of the water, including higher minimum instream flows, were expanded by the MIT/TPU Agreement.

Under the MIT/TPU Agreement, Tacoma agreed to constrain diversion of the First Diversion Water Right Claim (FDWRC) during certain drought conditions (see HCP Chapter 5.1). Tacoma also agreed to higher minimum instream flow levels than identified by state statute for the SDWR. Under terms of the MIT/TPU Agreement, water from the SDWR will not be available during much of the summer during average water years and will be severely limited during drought years. In addition, criteria are established under which Tacoma will contribute certain amounts of water to supporting streamflows in the Green River during low flow conditions.

2. Provision for Optional Storage of 5,000 Ac-Ft for Low Flow Augmentation

This measure provides for optional storage of up to an additional 5,000 ac-ft of water within HHD reservoir on an annual basis. This water can be used for low flow augmentation to improve fish and wildlife habitat conditions in the Green River.

3. Additional Water Storage (AWS) Project

Tacoma is the local sponsor for the USACE's proposed AWS project. The preferred alternative for the AWS project is a dual-purpose water supply and ecosystem restoration project with implementation of early spring refill of 20,000 ac-ft for Tacoma's SDWR water supply (i.e., Phase I). Flow-related benefits of the AWS project include a flow-management strategy that provides a block of water to be used to augment springtime flows for fishery benefits, including higher sustained baseflows during May and June and the potential release of freshets during the spring to improve outmigrant survival of juvenile salmon and steelhead.

Operation of Howard Hanson Dam, including the storage and release of water, are the responsibility of the USACE. The impacts of HHD water control activities on listed species were assessed in Section 7 consultation between the USACE, the U.S. Fish and Wildlife Service (USFWS), and the National Marines Fisheries Service (NMFS) (USFWS and NMFS are collectively referred to as the Services). NMFS' biological opinion for the Corp's maintenance, operation, and AWS project at HHD was issued in October 2000.

Habitat and ecosystem rehabilitation measures to be implemented as part of this HCP solely by Tacoma, or in cooperation with other parties include:

4. Upstream Fish Collection and Transport Facility at the Headworks

This facility will be used to capture upstream migrating adult anadromous salmonids, including chinook salmon, at Tacoma's Headworks diversion structure. These fish will be relocated into the upper Green River watershed to spawn. This measure will provide anadromous fish access to the upper watershed, which represents 45 percent of the Green River basin. This upstream passage approach was selected in lieu of laddering Tacoma's diversion dam due to the upstream proximity of HHD and the difficulty of laddering that 235-foot high structure.

5. Downstream Fish Passage Facility at HHD

A downstream passage facility will be partially funded by Tacoma (USACE 1998) to provide for downstream passage of juvenile salmonids and steelhead kelts (spawned steelhead adults that survive to potentially spawn again) through HHD.

6. Downstream Fish Bypass Facility at Headworks

A downstream fish bypass facility will be installed at Tacoma's Headworks to increase the survival of outmigrating juvenile salmonids.

7. Large Woody Debris Placements

Woody debris, including rootwads, will be placed in the free-flowing reaches of the upper Green River and the Headworks inundation pool. Woody debris (including both small and large woody debris) will also be collected in the HHD reservoir, transported downstream around HHD, and placed in the mainstem channel below the Headworks. Standing timber will be left in the newly inundated portion of Howard Hanson Reservoir to provide habitat complexity as well as a source of future LWD for other rehabilitation measures.

8. Gravel Nourishment

Gravel will be introduced into the Green River below the Headworks to augment the supply of gravels in the middle Green River. Gravel may be placed between HHD and the Headworks if deemed beneficial by the Services.

9. Side Channel Reconnection and Restoration

A large side channel (Signani Slough), which was separated from the Green River by the realignment of Burlington Northern Railroad tracks, will be reconnected to the main river channel to provide up to 3.4 acres of side-channel habitat. Conservation measures designed to address target baseflows during the spring and instream flow requirements during the summer will also provide for side channel connectivity with the mainstem Green River.

C. Analysis of effects by species and life stage

1. Chinook Salmon - Upstream Migration

a. Upper Watershed

(1) Water Withdrawal. The Headworks diversion structure currently prevents the upstream migration of adult chinook salmon above RM 61.0. Additionally, HHD at RM 64.5 has been a barrier to the upstream migration of chinook salmon into the upper Green River watershed since its construction in the early 1960s. HHD was originally authorized and built by the USACE without fish passage facilities. Blockage of migration into the upper watershed prevents access to approximately 40 percent of watershed. Chinook are typically mainstem river spawners, and likely will not use the HHD reservoir or the upper reaches of smaller tributaries for spawning. Nevertheless, based on gradient and elevation, there are approximately 24 miles of mainstem Green River available in the upper watershed (above the reservoir) suitable for chinook spawning (USACE 1998).

(2) Watershed Management. The four primary means by which forest management activities may affect the upstream migration of chinook are: 1) through deposition of coarse sediment from management related landslides, which creates or exacerbates subsurface flow conditions in low gradient sections of large tributaries or the mainstem Green River in late summer; 2) through elevation of temperatures caused by harvest of streamside vegetation, which may cause upstream migrating fish to avoid spawning areas with high temperatures; 3) through a reduction in LWD inputs, which may reduce the frequency and quality of deep pools and resting areas; and 4) by preventing access where roads cross streams. Recent watershed analyses (Plum Creek 1996; USFS 1996) indicate that deep pools required by adult salmonids for holding habitat are common in some portions of the mainstem and large tributaries in the Upper HCP Area. Flow is perennial in the mainstem and most large tributaries, although subsurface flows have been noted in lower Sawmill Creek and the North Fork Green River (USFS 1996). Subsurface flows are believed to have been exacerbated by sediment deposition from management-related mass wasting.

Temperatures have been measured periodically throughout the WAU since 1965, and, since they are generally less than 66° F (19° C) even in the late summer, are not believed to impede upstream migration. However, locally high temperatures have been attributed to low summer flows and harvest of riparian vegetation (Plum Creek 1996; USFS 1996).

Implementation of upland forest and riparian conservation measures will have a positive effect on upstream migration in the Upper HCP Area. Implementation of mass-wasting prescriptions developed through watershed analysis is expected to reduce management-related contributions of coarse sediment. Over the long-term, this could reduce the extent of aggraded reaches that consistently experience subsurface flows during dry summers. Reestablishment of riparian forests dominated by coniferous trees greater than 50 years old will increase shade, moderating elevated summer temperatures caused by lack of adequate shade. Increasing the proportion of riparian stands greater than 50 years of age from 27 to 100 percent will result in a gradual increase in the recruitment of LWD. In addition, the increased abundance of late-seral stands is expected to ensure that at least some of the LWD that enters the stream system is large enough to function as key pieces, which are especially important for forming deep pools in larger channels. Tacoma's ownership encompasses most of the mainstem and large tributary habitat preferred as holding habitat by large bodied salmonids such as chinook, thus temperature reductions and increased LWD inputs resulting from development of mature coniferous riparian forests on Tacoma's lands are expected to be especially beneficial for this species.

Stream crossing culverts on Tacoma's land will be inventoried, and repaired or replaced as necessary within 5 years of issuance of the ITP. Stream crossings will be maintained in passable condition for the duration of the ITP. This measure could increase the amount of habitat that is accessible to upstream migrating chinook, although the magnitude of that increase cannot be estimated until the inventory is complete.

b. Middle Watershed

(1) Water Withdrawal. The middle section of the Green River is much less channelized than the lower river, and certain areas represent a more natural condition (e.g., O'Grady Park section, RM 36.9 to 40.6) (Fuerstenberg et al. 1996). Because it is less constrained by levees, the middle Green River is significantly wider and shallower than the lower Green River. At a flow of 1,000 cfs at Auburn, the average wetted width of the middle Green River below the Green River Gorge is 148 feet, while the average wetted width of the lower Green River at the same flow is 119 feet (Caldwell and Hirschey 1989). Consequently, upstream passage of adult chinook salmon through the middle section of the river is susceptible to blockage by shallow riffles during late summer and fall low flow conditions.

The WDFW and MIT excavated channels through specific riffles for upstream migrating adult chinook salmon during severe drought conditions in 1987 when the annual 7-day low flow measured at the Auburn gage was 157 cfs (USGS gaging records). Under modeled natural conditions, the minimum annual seven-day low flow observed at the Auburn gage during the period from 1964 to 1996 was 172 cfs in October 1991, and the annual 7-day low flow in 1987 would have been approximately 193 cfs. Analysis of transect and stage discharge data collected by Ecology (Caldwell and Hirschey 1989) at shallow riffles in the middle Green River indicate that passage for adult chinook salmon should not be impeded by flows greater than 225 cfs (i.e., those flows providing passage depths of one foot and greater). Modeled flow data suggest that flows fell below this level approximately 10 percent of the time during early September under natural conditions.

Table 6. Selected hydrologic characteristics of flows in the Green River at Auburn under the modeled natural flow regimes for the period from 1964 to 1995 (Source: CH2M Hill 1997).

	Natural			HCP		
	Min	Mean	Max	Min	Mean	Max
Annual 3-day Max.	3,447	8,798	17,759	3,349	7,561	12000
Annual Mean Daily Flow	932	1,409	2,086	773	1,231	1893
Annual Number of Spring Freshets[1]	0	4.60	10	0	5.30	10
Duration of Spring Freshets	1	5	28	1	5	27
7-day Low Flow						
April 1-May 30	447	1,178	2123	385	876	1998
July 15-Sept 15	203	290	462	250	294	400
Annual	172	268	462	183	303	429

[1] Spring freshets equal continuous flows greater than or equal to 2,500 cfs that occur between 1 February and 30 June.

The MIT/TPU Agreement requires minimum flows of 250 cfs or greater at the Auburn gage during all but drought years, when minimum flows may be reduced to 225 cfs following coordination with resource agencies and the MIT (see HCP Appendix B). Consequently, Tacoma's water withdrawals are not expected to result in blocked upstream passage of adult chinook salmon through the middle Green River even during drought years. The provision of a minimum flow of 225 cfs during drought conditions should satisfy the upstream passage requirements of chinook salmon in the middle Green River. The 225 cfs minimum flow provided under the HCP represents an increase of more than 10 percent relative to the extreme 7-day low flow observed between 15 July and 15 September under the modeled natural flow regime. The model data indicate that average 7-day low flows of as little as 183 cfs could occur at the Auburn gage under the HCP during late September or October; however, these extreme events still represent a 6 percent increase over the minimum annual 7-day low flow under modeled natural conditions for the same time period. Flows exceed 250 cfs at Auburn more than 90 percent of the time under the modeled HCP flow regime, however the overall duration of low flows increased by approximately two weeks.

(2) Watershed Management. Tacoma's watershed management activities and conservation measures will not affect chinook upstream migration in the middle watershed.

c. Lower Watershed

(1) Water Withdrawal. Tacoma's water withdrawals have the potential to influence the upstream passage of chinook salmon more than other anadromous fish species present in the Green River. Adult chinook salmon are larger than most other salmonids and require greater water depths to move upstream over riffle areas. Chinook salmon also migrate upstream during the late summer and early fall, coincident with the lowest flow levels occurring in the Green River. Based on data collected at riffle areas in the lower river during the Washington State Department of Ecology's (Ecology) instream flow study (Caldwell and Hirschey 1989), water depths in the lower river are sufficient for upstream passage of chinook when flows at the Auburn gage exceed 200 cfs. Between 1962 and 1996, the lowest seven-day flow measured at the Auburn gage was 157 cfs during October 1987 (source: USGS gaging records). Under modeled natural conditions, the minimum annual seven-day low flow observed at the Auburn gage during the period from 1964 to 1996 was 172 cfs in October 1991 and the annual 7-day low flow in 1987 would have been approximately 193 cfs.

The minimum instream flow requirements for the fall migration period of chinook salmon, established under the MIT/TPU Agreement and maintained by reductions in diversions and low flow augmentation storage in HHD, will result in flows which provide adequate water depths for the upstream passage of chinook salmon in the lower river compared to those occurring under natural conditions. The minimum flows required under the MIT/TPU Agreement (i.e., 250 cfs at Auburn during average and dry years and 250 to 225 cfs during drought years) will provide the physical conditions necessary for upstream passage of this species. However, some delay may continue to occur during sustained low flow periods due to poor water quality conditions and lack of migration cues.

The AWS project includes a provision for the optional annual storage of up to 5,000 ac-ft of water to be used for fisheries purposes. Under dry year or drought conditions, some of this storage could be targeted to augment flows or provide a freshet in the late summer or early fall when adult chinook salmon are holding in the lower Green/Duwamish rivers prior to upstream migration. The instream flows contained in the MIT/TPU Agreement should be sufficient for upstream chinook passage, but under the adaptive management strategy, the opportunity exists to adjust releases to meet unanticipated fisheries needs.

Watershed Management. Tacoma's watershed management activities and conservation measures will not affect chinook upstream migration in the lower watershed.

2. <u>Chinook - Downstream Migration</u>

a. Upper Watershed

(1) Water Withdrawal. The potential effects of Tacoma's water withdrawals on the downstream passage of juvenile chinook salmon occur largely below the Headworks diversion facility (including the diversion dam and pool). The only exception to this is the pumping of water from the North Fork well field above HHD, and its effects on flows in the North Fork Green River.

Potential effects of water storage on downstream migration are addressed as a USACE activity covered under Section 7 of the ESA and are not addressed in this HCP.

While the majority of Tacoma's M&I water withdrawal from the Green River basin occurs at the Headworks at RM 61.0, water is pumped at the North Fork well field above HHD when the turbidity in the mainstem Green River approaches 5 nephelometric turbidity units (NTU). Periods of high turbidity in the mainstem Green River are typically associated with late fall, winter and early spring storm events that wash sediments into the reservoir. High turbidity levels may also occur as a result of mass-wasting events along the HHD reservoir shoreline or upper mainstem tributaries. Groundwater from the North Fork well field is always clear and free of suspended sediments, and provides an alternate water source for use during such periods of high turbidity in the river. The well field is used approximately eleven days per month between November and May to supplement flow into Pipeline No. 1 (P1) to maintain a turbidity level of less than five nephelometric turbidity units.

Active pumping of the North Fork well field reduces surface flow in the North Fork of the Green River above HHD and could affect downstream migration conditions for juvenile chinook in the North Fork. There is an assumed continuity between North Fork well field groundwater and surface flow in the North Fork, but the effect of pumping on surface flows is difficult to discern when North Fork surface flows are high. The North Fork well field is used during periods of high turbidity in the mainstem Green River, which typically coincide with high surface flows in the North Fork. Use of the well field during the spring outmigration season is therefore assumed to have minimal effects on outmigrating chinook juveniles.

While the USACE is responsible for the effects of water storage and release at HHD, Tacoma will be the local sponsor of the downstream fish passage facility to be installed at HHD. The operation of this facility is important to maintain high levels of chinook salmon smolt survival through Howard Hanson Reservoir and Dam following re-introduction of this species into the upper Green River. The estimated survival rate for combined reservoir and dam passage resulting under operation of the HHD fish passage facility is 64 percent, compared to a survival rate of 8 percent under pre-AWS project conditions (USACE 1998, Appendix F1, Section 8E). We described 64% as being at the low end of the range of successful downstream passage that might correlate with stock sustainability. However, our analysis did conclude that this passage rate, along with other observed life history stage survival rates, might be expected to achieve a self sustaining run upstream of HHD under contemporary marine survival rates.

(2) Watershed Management. Extensive harvest of forest stands at elevations that commonly develop a snowpack but also frequently experience heavy, warm winter rains may increase the magnitude of peak flows (WFPB 1997). However, in the Pacific Northwest, the majority of such events occur during late November and February, prior to the period when juvenile salmonids begin to move downstream. Prescriptions developed through watershed analysis constrain harvest activities in subbasins deemed to be vulnerable to peak flow increases (Appendix D) Since forestry activities are not expected to influence flows during the salmonid outmigration season (April through June in the Green River basin) and watershed analyses prescriptions will prevent excessive peak flow increases, neither Tacoma's forest management activities or conservation measures will affect downstream migration.

b. Middle and Lower Watershed

(1) Water Withdrawal. Tacoma's water withdrawals could have two effects on the survival of outmigrating juvenile chinook salmon. First, some of the outmigrating juveniles passing through the Headworks diversion pool could be impinged on the existing screens or entrained into the water intake at the diversion. Fish impinged on the screens or entrained into the water supply system are assumed to ultimately perish. Existing screens at the Headworks do not meet NMFS design criteria. Since the NMFS design criteria represents state-of-the-art in downstream fish passage protection, screens that do not meet design criteria present a potential risk to outmigrating salmonids. Data on existing outmigrant entrainment and survival at Tacoma's Headworks are not available.

Second, the survival of outmigrating juvenile salmon in the middle and lower Green River below the Headworks is assumed to be affected by the timing and quantity of instream flows. Although the relationship between flow and migration survival is poorly understood, survival is assumed to increase as flows increase (Wetherall 1971). Tacoma's water withdrawals of up to 113 cfs under the FDWRC at the Headworks represent about 10 percent of the flow in the Green River during the mid-March to mid-June chinook outmigration season. Based on the assumptions of Wetherall (1971), Tacoma's diversions are expected to result in decreased outmigrant survival conditions by reducing flows in the Green River below the Headworks. Using Wetherall's data for juvenile chinook salmon, the USACE developed a survival-to-flow function for outmigrating juvenile salmonids in the Green River for the purpose of assessing the benefits of proposed flow augmentation during May and June under the AWS project (USACE 1998; Appendix F, Section 5).

In order to assess the impact of Tacoma's diversions on the survival of outmigrating chinook salmon, daily estimates of changes in chinook outmigration conditions were calculated for proposed Green River flows under the HCP (Green River flows with the AWS project and with Tacoma withdrawals) and compared to Green River flows without the AWS project and without Tacoma withdrawals. Using the survival-to-flow function developed for the Green River from the Wetherall 1971 data, estimated daily changes in survival conditions were calculated during the chinook salmon outmigration period (March 15 through June 15) from daily flow values predicted by the HHD hydrology model for the period 1964-1995.

The results of this analysis indicate that the flow reductions below the Headworks caused by diversions under the FDWRC and SDWR result in an estimated average reduction in juvenile chinook outmigrant survival conditions of 5 percent. Reductions in estimated yearly outmigrant survival conditions ranged from 1.3 to 7.1 percent for the 1964-1995 period.
Under this HCP, Tacoma will install a downstream fish bypass facility at the Headworks at RM 61.0 that includes a 220-ft- by 24-ft conventional screen. This screen will employ design that meets NMFS' criteria and ensure that juvenile impingement and entrainment are kept to the

technically feasible minimum. If impingement or entrainment is occurring with the existing screen, it will be reduced or eliminated.

Flow augmentation in May and June resulting from implementation of the AWS project-Phase I will also improve outmigration survival conditions for juvenile chinook salmon in the Green River. The benefits to chinook salmon migrants provided by AWS project spring flow augmentation measures were calculated using the same method used to calculate the impacts of the diversions on outmigrant survival conditions, except that the benefits were calculated by subtracting the daily survival values occurring under Green River flows with the AWS project and with Tacoma withdrawals from those occurring under Tacoma withdrawals assuming the AWS project was not completed. The average improvement in the index of juvenile chinook outmigrant survival condition resulting from the AWS project is 2.3 percent. Estimated increases in yearly survival conditions resulting from the implementation of this measure range from 0.5 percent to 4.2 percent improvement for the 1964 through 1995 period.

The predicted change in juvenile salmonid migration conditions calculated as part of this HCP represents a net change between modeled scenarios. The values do not translate to a specific number of fish, or to a measurable change in fish survival. The values represent an index of migration survival; that is, changes in downstream migration condition are assumed to relate to changes in outmigrant survival, but the specific relationship is unclear. The effect of small changes in the index of downstream migrant condition could have effects unforeseen based simply on the calculated degree of change. If stream conditions are already marginal, a small change in instream conditions could have unanticipated effects. The analysis used in the HCP does not identify the baseline condition of the population, but simply describes the percent change between modeled scenarios.

(2) Watershed Management. Tacoma's watershed management activities and measures will not affect chinook downstream migration in the middle and lower watershed.

3. <u>Chinook - Spawning and Incubation</u>

a. Upper Watershed

(1) Water Withdrawal. Tacoma's water withdrawals at the Headworks will not affect spawning habitat and incubation of chinook salmon in the upper Green River basin above HHD. However, pumping of groundwater from the North Fork well field could affect chinook spawning and incubation in the North Fork of the Green River. During late summer, surface flows in the North Fork channel upstream of the well field drop below 5 cfs and in some years cease to flow for several days to weeks. During this time, groundwater in the vicinity of the well field can contribute to surface flows in the lower North Fork channel one-half mile or more downstream of the well field. If pumping reduces surface flows in the lower North Fork, adult chinook transported upstream past the Headworks and HHD may not find suitable spawning habitat there until fall rains increase surface flows. Since pumping of the North Fork well field typically occurs with the onset of fall rains, effects on chinook spawning and incubation are predicted to be minor.

(2) Watershed Management. Salmonids require stable gravels that have low concentrations of fine sediment and organic material for successful spawning. Forest harvest and road building can substantially increase the delivery of fine sediment to streams through both surface erosion and mass wasting. Recent watershed analyses conducted in the upper Green River basin identified a number of landforms with high rates of management-related mass wasting, and noted a number of tributary basins where the amount of road-related surface erosion increased sediment delivery by over 50 percent of the background rate (Plum Creek 1996; USFS 1996). Data on spawning gravel quality from the Lester WAU indicate that tributary spawning habitat currently contains moderate to high levels of fine sediment (> 12 percent by volume) (Plum Creek 1996).

Implementation of mass-wasting prescriptions and the RSRP developed through watershed analysis will reduce management-related contributions of fine sediment to less than 50 percent over background. Reducing fine sediment inputs is expected to result in a decrease in the proportion of fine sediment contained by spawning gravels, and could result in increased survival to emergence. Species such as chinook, that spawn in low gradient reaches prone to deposition of fine sediment, will benefit most from improved gravel quality.

Loss of LWD through decreased recruitment or intentional removal may result in a loss of spawning gravels, particularly in higher gradient channels with a high sediment transport capacity. Approximately 57 percent of the moderate to high gradient channels in the Lester WAU had "poor" LWD frequencies (< 1 piece/channel width) (Plum Creek 1996). Lack of spawning gravel was identified as a potential limiting factor to salmonids in the upper Green River watershed (USFS 1996). Since gravel recruitment has increased as a result of management-related mass wasting, the current lack of spawning gravel is hypothesized to be the result of the lack of storage sites provided by LWD.

Reestablishment of riparian forests dominated by coniferous trees greater than 50 years old will result in a gradual increase in the recruitment of LWD. In addition, the increased abundance of late-seral stands is expected to ensure that at least some of the LWD that enters the stream system is large enough to function as key pieces, which are especially important for forming stable flow obstructions in larger channels. The net result should be an increase in in-channel LWD and an associated increase in the availability of spawning gravel. Spawning chinook may benefit most from increased spawning gravel availability in moderate to high gradient tributary streams where storage is currently limited.

b. Middle Watershed

(1) Water Withdrawal. Tacoma's water withdrawals can affect the availability of chinook spawning habitat in both the mainstem river and side channel areas of the middle Green River. The side channels in this section of the river provide important habitat for salmon spawning, incubation, and juvenile rearing (Fuerstenberg et al. 1996; USACE 1998). Reduced flows can also increase the susceptibility of chinook salmon redds to dewatering by exposing mainstem and side channel areas during the incubation period.

The potential effects of Tacoma's withdrawals on mainstem spawning habitat in the middle Green River were quantified using the results of an instream flow study conducted in the lower and middle Green River by Ecology (Caldwell and Hirschey 1989). Potential habitat area and flow functions were developed for chinook salmon spawning at four IFIM (Instream Flow Incremental Methodology) study sites established in the middle Green River. The potential habitat area values produced by this study represent the total amount of potential habitat resulting from a given flow, weighted according to the suitability for spawning of the velocity, depth, and substrate that are predicted to occur under that flow. The daily potential habitat values occurring during the spawning period of chinook salmon under Green River flows with Tacoma withdrawals and Green River flows without Tacoma withdrawals were calculated using these potential habitat and flow functions. Daily flow values for Auburn and Palmer gaging control points were obtained from the CH2M Hill hydrology model; these values were modified to remove inflows from Big Soos Creek and Newaukum Creek for IFIM sites located above these tributaries. Based upon this analysis, chinook salmon spawning habitat in the main channel of the middle Green River could be reduced by an average of 11.1 percent by exercise of the FDWRC and SDWR. The greatest decrease in spawning habitat caused by the diversions (-31.5 percent) was predicted during 1987, a drought year. In contrast, the diversions resulted in an 11.4 percent improvement in spawning habitat area during 1968, a wet year. High flows occurring during the fall of 1968 exceeded the range of flows determined to be optimal for chinook salmon spawning by the IFIM model. The Physical Habitat Simulation model of the IFIM uses measurements and subsequent modeling of depth, velocity, substrate, and cover to describe potential salmon spawning habitat. Chinook salmon also have a strong preference for subgravel flow in the choice of redd sites. The chinook's apparent selection of areas containing strong subsurface flow may mean that suitable chinook spawning habitat is more limited than what the model results might otherwise suggest.

The potential effects of Tacoma's water withdrawals on chinook spawning habitat area in the side channels of the middle Green River were quantified using wetted side channel area versus discharge relationships developed based on field studies conducted in support of the AWS project (USACE 1998). Separate curves were developed for side channels located between RM 57.0 and RM 60.3 (referred to as Palmer Segment), and for side channels located between RM 33.8 and RM 45.5 (referred to as Middle Green Segment). Values of side channel habitat in each of these two segments were calculated on a daily basis for the chinook salmon spawning period (1 September through 30 November) using daily discharge values predicted at the Palmer and Auburn gages by the CH2M Hill hydrology model. Side channel habitat values were calculated for Green River flows with the AWS project and with Tacoma withdrawals compared to Green River flows without the AWS project and without Tacoma withdrawals. The results of these analyses indicate that Tacoma's withdrawals could reduce the wetted area of side channels in the middle Green River (both segments combined) by an average of 16 percent during the 1964-

1995 period. This represents a 1.5-acre reduction in the average wetted area of side channels in the middle Green River during the chinook salmon spawning period.

Chinook salmon redds constructed during periods of high flow are more susceptible to dewatering than redds constructed when Green River flows are low, which have a higher chance of remaining wetted through the incubation period. Conversely, chinook spawning during periods of low flow may result in the concentration of redds near the center of the channel; these redds are susceptible to destruction by bed movement during flood events. The analysis of spawning and incubation identified potential loss of redds due to dewatering, but did not address redd destruction due to flood events.

The potential impacts of Tacoma's FDWRC and SDWR withdrawals on chinook salmon incubation were assessed by calculating spawnable widths and dewatered channel widths on a daily basis during the chinook spawning period. The spawnable width for chinook salmon was calculated by: 1) determining the stage of the river for a given daily flow; 2) subtracting 1 foot from this stage because chinook salmon require a 1 foot minimum depth to spawn; and 3) calculating the wetted width of the river channel for this lower stage value. The dewatered width was calculated by determining the spawnable width for a given day, and then subtracting the width occurring during the lowest two-day flow event in the 90 days (i.e., chinook salmon egg-to-fry emergence period) following that given day. Spawnable widths and dewatered widths for chinook salmon were calculated from transect and rating curve data obtained from Nealy Bridge Transect 4 of Ecology's Green River instream flow study. Ecology observed a high intensity of chinook salmon spawning in the vicinity of this transect (Caldwell and Hirschey 1989).

The average spawnable width of the main river channel during the chinook salmon spawning period was predicted to be 135.7 feet without Tacoma's water withdrawals, and 134.5 feet with the water withdrawals. For days when dewatering was predicted to occur, the dewatered spawnable width of the channel averaged 3.9 feet without Tacoma's water withdrawals, and 4.1 feet with the water withdrawals. Thus, the water withdrawals are predicted to result in an average increase of 0.2 feet in the dewatered width of the channel for those days when dewatering is predicted to occur. This represents a very small portion of the total width of the channel (i.e., 0.15 percent) within which chinook salmon can potentially spawn. The modeled water withdrawals were not found to increase the frequency of dewatering during the 90-day chinook salmon incubation period. Dewatering of some portion of the spawnable width of the channel during the 90-day chinook incubation period is predicted to occur for an average of 14 days both with and without the withdrawals. The results of this analysis indicate that Tacoma's water diversions will have a minor impact on the risk of dewatering of chinook salmon eggs and embryos in mainstem sections of the middle Green River.

In addition to changes in the amount of time that redds are exposed to dewatering, changes in streamflow can affect the survival of chinook eggs by reducing the rate of oxygen exchange as water flows over the eggs (Healey 1991). Chinook have the largest eggs of the Pacific salmon species and thus, their eggs have a small surface-to-volume ratio compared to other salmon. The small surface-to-volume ratio of the eggs suggests that chinook salmon eggs may be especially sensitive to low oxygen concentration. Reductions in surface streamflow can affect the velocity of the water flowing through the gravel and reduce the rate of oxygen exchange at the egg surface. During the period of drought extending through late October, extreme low flow conditions could affect the survival of chinook eggs by reducing the rate of oxygen exchange. In addition, during drought conditions, the temperature of the water may increase and as the temperature of water increases, the maximum concentration of dissolved oxygen decreases. Tacoma's water withdrawals under the SDWR during October are constrained by insteam flows specified in the MIT/TPU Agreement. The minimum flow levels in the MIT/TPU Agreement during October are 300 cfs, compared to state minimum flows of 190 to 240 cfs (Chapter 173-509 WAC).

The impacts of Tacoma's water withdrawals on chinook incubation habitat in the side channels of the middle Green River were assessed using the side channel habitat area versus discharge curves developed by the USACE (1998). Effects of the diversions on chinook incubation habitat were quantified by comparing continuously wetted side channel habitat for the lowest two-day flow event during the chinook incubation period between Green River flows with the AWS project and with Tacoma withdrawals compared to Green River flows without the AWS project and without Tacoma withdrawals. The results of this analysis indicated that Tacoma's diversions could reduce side channel habitat between RM 61.0 and RM 33.8 by 1.4 acres (i.e., change of 18.2 percent) from that occurring without the diversions.

The foremost mitigation measure that will increase the availability of chinook salmon spawning habitat in the Green River is the fish collection and transportation facility, which will add 24 miles of mainstem spawning habitat for chinook salmon in the upper Green River watershed to that currently available to fish in the lower and middle Green River. The gravel nourishment conservation measure (see HCP Chapter 5) will also benefit spawning habitat conditions in the middle Green River by augmenting gravel recruitment lost from the upper watershed due to the construction of HHD. Reconnection and rehabilitation of side channels will increase spawning habitat availability by providing up to 3.4 acres of accessible habitat in the middle Green River. The early reservoir refill, spring flow augmentation, and freshets proposed as part of the AWS project will have little effect on chinook spawning and incubation. These mitigation measures affect flows in the Green River from late February to June, whereas the combined spawning and incubation period for chinook salmon extends from September through February.

(2) Watershed Management. Tacoma's watershed management activities and conservation measures will not affect chinook spawning and incubation in the middle watershed.

c. Lower Watershed

(1) Water Withdrawal. Spawning habitat in the lower Green River watershed is relatively poor compared to that in the middle watershed because of both the nature of the geologic deposits and as a consequence of extensive channelization and sedimentation. Potential chinook spawning habitat and discharge relationships obtained for the Kent Site of the Ecology instream flow study (Caldwell and Hirschey 1989) were used to quantify the potential impacts to chinook salmon spawning habitat in the lower Green River. Tacoma's water withdrawals were estimated to reduce potential chinook spawning habitat in the lower Green River by an average of 15.5 percent. This estimate applies to main channel habitat only; there are few side channels of significant size in the lower Green River due to the presence of flood control dikes and levees along most of the lower river.

As stated earlier, the foremost conservation measure for increasing chinook salmon spawning habitat in the Green River is the set of fish passage facilities, which will enable salmon and steelhead to be re-introduced to the upper watershed to spawn naturally. The construction and operation of the facilities will add 24 miles of potentially high quality spawning habitat for chinook salmon in the upper Green River watershed to the habitat currently existing in the lower and middle Green River. The opportunities for improving spawning habitat in the lower Green River are very limited due to the disturbed condition of the river channel for flood control.

4. <u>Chinook - Juvenile Rearing</u>

a. Upper Watershed

(1) Water Withdrawal. The potential effects of Tacoma's water withdrawals on juvenile chinook habitat will occur primarily in the lower and middle Green River (i.e., below Headworks). Pumping of groundwater from the North Fork well field is expected to have little effect on chinook rearing in the North Fork Green River since well field pumping primarily occurs during late fall, winter and early spring high flow periods. Researchers from the U.S. Fish and Wildlife Service (USFWS) (Wunderlich and Toal 1992) observed an abundance of chinook rearing sites in the lower North Fork, but noted that chinook appeared to use the North Fork for short-term rearing and as a transportation corridor. Use of the North Fork by juvenile chinook appeared to be completed by early July when flows naturally begin to decrease.

The observed movement of chinook fry out of the North Fork channel by early July is consistent with an ocean-type early life history where chinook fry migrate to the estuary within 30 to 90 days of emergence (see HCP Appendix A). Although USFWS researchers observed movement of chinook fry out of the North Fork channel by early July, the proportion of chinook juveniles migrating as newly emerged fry, fingerlings or yearlings may change if a naturally reproducing stock is re-established in the upper watershed.

A number of habitat rehabilitation projects will be implemented by Tacoma and the USACE in the upper watershed as the restoration component associated with Phase I of the AWS project. Although aquatic habitat in the upper watershed is in good condition compared to the lower watershed, much of the area has been impacted by logging (Plum Creek 1996). Restoration projects to be implemented during the AWS project include placement of LWD in approximately 1.5 miles of the mainstem Green River, and approximately 2.6 miles of tributary habitat in the

North Fork Green River, Charley, Gale, MacDonald, Cottonwood, and Piling creeks. Large woody debris loadings will be brought up to levels considered representative of “good” habitat conditions according to the WDNR watershed analysis criteria (WFPB 1997) or comparable metrics approved by the Services. In addition, approximately 2.4 acres of off-channel habitat will be created adjacent to the mainstem Green River, North Fork Green River, and large tributaries. Creation of off-channel habitat will involve excavating and placing wood in side channels, beaded ponds, or dendrites. The addition of LWD and creation of off-channel areas will provide immediate benefits to rearing and overwintering juvenile chinook.

The pool raise associated with the AWS project is a USACE action and will replace free-flowing streams with a slack-water reservoir pool. The loss of rearing habitat in the inundated stream areas may be partially offset by the larger HHD pool. USFWS studies of HHD reservoir (Dilley and Wunderlich, 1992, 1993; Dilley 1994) found tremendous growth rates for chinook juveniles in lower and upper reservoir areas. The physical loss of stream habitat resulting from the AWS project pool raise will be mitigated by the USACE through a series of habitat improvements implemented in the inundation zone, reservoir perimeter, and mainstem channel and tributaries. These actions, which include placement of LWD in 11.5 miles of mainstem and 2.4 miles of tributary habitat in the inundation zone and channels upstream of the reservoir, will provide additional benefits for juvenile salmonid rearing. An additional 1.1 acres of off-channel habitat (beaded ponds, side channels, and dendrites) will be created, and boulders and LWD will be used to stabilize the banks and maintain the existing channel configuration in the new seasonally inundated reaches. Although these mitigation actions are associated with water storage in the HHD reservoir by the USACE (a federal action), Tacoma will fund the construction, monitoring, and maintenance costs over the 50-year project period under this HCP.

(2) Watershed Management. Most juvenile salmonids rear in pools or in quiet areas along channel margin. In the summer, juvenile fish require adequate flows, cover, cool temperature, and sufficient food inputs. Juvenile chinook that remain in freshwater through the winter move out of tributary streams into the mainstem, seeking out low velocity pools with LWD for cover, or holding in crevices within coarse cobble and boulder substrate. LWD may be particularly important for providing cover and refuge from high flows.

Forest management activities can have a profound effect on rearing habitat. Management-related landslides can bury LWD, and fill pools and interstitial spaces in the substrate. Increased fine sediment inputs may also increase embeddedness. Lack of adequate LWD recruitment may decrease the frequency of deep pools with abundant cover. Blocked or inappropriately designed culverts may prevent young fish from accessing small tributaries and off channel habitat. Dam-break floods may travel long distances down moderate to high gradient tributaries, particularly in reaches that lack large coniferous trees in the riparian zone (Coho 1993). Such events may scour virtually the entire bed, injuring or killing fish residing in the channel. Low pool frequencies, lack of LWD, and the scarcity of off channel habitat all currently limit salmonid fishes in the upper Green River basin (Plum Creek 1996; USFS 1996).

Implementation of upland forest and riparian management conservation measures will have a positive long-term effect on juvenile rearing in the Upper HCP Area. Implementation of mass-wasting prescriptions is expected to reduce the frequency of landslides that deliver sediment to low-gradient channels or initiate dam-break floods. Management-related contributions of fine sediment will be reduced to less than 50 percent over background under the RSRP. These measures are expected to result in a decrease in embeddedness, which will benefit juvenile chinook overwintering in interstitial spaces.

Reestablishment of riparian forests dominated by coniferous trees greater than 50 years old will result in a gradual increase in the recruitment of LWD. As in-channel LWD increases, the frequency of pools is also expected to increase. Pool quality will improve as a result of the additional cover provided by LWD. The net result should be an increase in the quality and quantity of pool habitat used for summer and winter rearing by all species. As riparian stands mature, the number of large conifers capable of acting as barrier tress during dam-break floods will increase. The increased abundance of barrier trees, combined with the decreased frequency of mass wasting is expected to reduce the risk of dam-break floods.

b. Middle Watershed

Tacoma's water withdrawals could affect chinook salmon juvenile rearing habitat by reducing flows in the Green River below the Headworks up to 213 cfs on a daily basis. Chinook salmon fry begin emerging in the Green River in January and some migrate seaward immediately after yolk absorption. Prior studies conducted in the Green River and general reviews of the life history of fall chinook salmon suggest that most chinook fry outmigrate in April to June. Surveys of side channel habitats in the middle Green River in 1998 support the assumption that most chinook fry in the Green River system migrate downstream 30 to 90 days after emergence (Jeanes and Hilgert 1998). However, based on those sampling efforts and sampling efforts by MIT biologists in the Duwamish estuary, some chinook juveniles are thought to move seaward as fingerlings in the late summer of their first year, while others overwinter and migrate as yearling fish. The proportion of fingerling and yearling migrants may vary from year to year.

The evaluation of the potential effects of Tacoma's water withdrawals and habitat conservation measures assumed the majority of chinook fry in the Green River migrate seaward from April through early June after spending 30 to 90 days rearing in fresh water. While rearing in the Green River, chinook fry occupy backwater and low-velocity areas along the mainstem margin and side channels. During this period, flows in the mainstem Green River are generally higher than considered optimal by Ecology's instream flow study (Caldwell and Hirschey 1989).
The potential effects of Tacoma's withdrawals were quantified using IFIM potential habitat area and flow functions developed by Ecology for juvenile chinook salmon in the middle Green River. Daily habitat values occurring under proposed HCP conditions (Green River flows with the AWS project and with Tacoma withdrawals) were compared with those occurring under Green River flows without the AWS project and without Tacoma withdrawals (see HCP Chapter 7.1.3.2 for a description of the methods used for this habitat analysis). The results of this analysis indicate that the effects of the FDWRC and SDWR modeled from 1964 through 1995

was a 11.4 percent increase in available juvenile chinook habitat in the middle Green River. Increases in juvenile habitat area resulting from the municipal water use occur because flows in the middle Green River are usually higher than the flows considered to be optimal for juvenile chinook salmon by the Ecology instream flow study (Caldwell and Hirschey 1989).

The Ecology study did not develop potential habitat and flow functions for chinook fry, but since chinook fry are weaker swimmers than the larger juveniles modeled in the Ecology study, chinook fry should benefit even more than juveniles from the benefits of lower velocities in the mainstem channel. Tacoma's water withdrawals will reduce flows in the mainstem during the spring rearing period, but the benefit of lower velocities associated with reduced flows is countered by loss of side channel rearing areas. In addition, the results of Ecology's instream flow model have been questioned by state and tribal biologists who maintain the model did not adequately portray the effects of reduced flow on mainstem margins.

The potential effects of Tacoma's water withdrawals on chinook fry rearing habitat in the side channels of the middle Green River were quantified using wetted side channel area versus discharge relationships developed by the USACE (USACE 1998, Appendix F1, Section 7). Changes in availability of side channel area were calculated for the period 15 February through 31 May. The results of the modeling effort identified an average 18.4 percent reduction in wetted side channel area between RM 61.0 and RM 33.8 during the 32-year period from 1964 through 1995. This represents a 1.42-acre reduction in the average wetted area of side channels in the middle Green River during the chinook fry rearing period.

The conservation measures designed to improve juvenile chinook salmon habitat in the middle Green River include reconnecting and restoring the Signani Slough side channel, and placement of LWD in the river channel. These measures will improve juvenile chinook salmon habitat by providing up to 3.4 acres of additional off-channel habitat, which is important for overwintering, and by increasing the structural complexity of main channel habitats. Anchored LWD would be placed at two sites upstream of Tacoma's Headworks but downstream of HHD. Up to 50 percent of the wood currently intercepted by HHD would be placed or anchored downstream of the Headworks. Adding LWD will increase the complexity and quality of habitat in the middle Green River.

In addition, benefits will also be realized for several miles of the Green River immediately below HHD by improving (decreasing) water temperatures for fish. To evaluate this benefit, a temperature model was developed for HHD and the lower and middle Green River basins (Valentine 1996; USACE 1998). Analyses compared the proposed AWS project alternative (existing tower with a selective water withdrawal) with use of the existing tower with no modification. The objective of the USACE analyses was to determine if measures could be implemented to correct historic summer water temperature problems associated with HHD. The analysis used WESTEX, a one-dimensional, numerical, thermal budget model, which was modified to include the fish passage facility. Under the AWS project, spring, summer and fall flows will be released from HHD through selective withdrawal from a combination of the new fish passage facility with a surface intake, and from the radial gates at the bottom of the reservoir. Temperature modeling results indicated that the natural inflow to HHD exceeds the state Class "AA" temperature standard of 16.0˚C in most years. Modeling results for the AWS project indicated that releases will exceed this temperature in only one of 33 years. The preferred fish passage alternative, therefore, has a reliability of 97 percent for maintaining HHD release temperatures below the state standard. By the time the water reaches the downstream end of the Palmer spawning reach (RM 58.0-61.0), the benefit will be diminished as stream temperatures reach equilibrium with air temperatures.

(2) Watershed Management. Tacoma's watershed management activities and conservation measures will not affect juvenile chinook rearing in the middle watershed.

c. Lower Watershed

(1) Water Withdrawal. As with the middle Green River, flow reductions resulting from the FDWRC and SDWR could improve mainstem habitat conditions for late summer or yearling juvenile chinook salmon in the lower Green River but could reduce availability of side channel habitats. Municipal water use modeled using daily flows from 1964 through 1995 for the lower river resulted in an average 19.0 percent increase in mainstem habitat for juvenile chinook. Improvements in mainstem juvenile habitat area resulting from the water supply diversions occur because flows in the lower Green River are usually higher than the flow considered to be optimal for juvenile chinook salmon by Ecology's instream flow study. Since there is little off-channel habitat in the lower Green River due to channelization and flood control, loss of off-channel habitat will be small.

Water quality problems within the lower Green River include water temperature, DO, nutrient enrichment, and a variety of pollutants. Dissolved oxygen problems are related to both elevated water temperatures and nutrients and are most severe in the lower Duwamish within the tidal zone (up to RM 11.0). Such conditions can stress fish and render them more susceptible to the effects of other pollutants. However, the effects of HHD, Tacoma's water withdrawal activities, and the proposed habitat conservation measures on water temperature do not extend sufficiently far downstream to materially affect the lower Green River basin.

Because juvenile chinook salmon habitat is generally poor as a result of channelization in the lower Green River, mitigation measures for juvenile chinook salmon will focus on habitat enhancement of the upper and middle Green River, including LWD placement and side channel restoration.

(2) Watershed Management. Tacoma's watershed management activities and conservation measures will not affect juvenile chinook rearing in the lower watershed.

5. Summary of Effects of Water Withdrawal on Chinook Salmon

Withdrawing water is the primary action Tacoma is taking that may affect listed chinook salmon. Attending the water withdrawal action are Tacoma's numerous conservation measures and the

AWS project. River flow supplementation from the AWS project also has several effects on listed chinook and other unlisted species. These effects are briefly summarized from Tables 7-2 through 7-8 of the HCP. Juvenile chinook migrant to adult survival is estimated to be reduced 5.02% on average, with 7.13% at the extreme. Juvenile chinook outmigrant to adult survival is estimated to increase 2.34% as a result of supplemented flows. Chinook salmon spawning habitat reductions in the lower and middle river are estimated at 15.5% and 11.1% respectively, on average. Side channel habitat in the middle Green River are estimated as an average 16% reduction. Water withdrawal is estimated to reduce chinook spawnable channel width an average of 1.2 feet. The dewatered channel width during the spawning period would be 0.2 foot. The reduction in continuously wetted side channel area in the middle river during the chinook incubation period is calculated at 1.4 acres, or 18.2%, but would be offset 0.1% by AWS project flows. The effect of withdrawal on juvenile chinook rearing habitat in the lower and middle Green River increases by 19% and 11.4%, respectively. The offset from AWS project flow is estimated at 1.8% and 2.1%, respectively. Water withdrawal will reduce continuously wetted side channel juvenile chinook fry rearing habitat during the spring by 18.4%.

6. <u>Coho Salmon - Upstream Migration</u>

a. Upper Watershed

(1) Water Withdrawal. The Headworks diversion structure prevents the upstream migration of adult coho salmon above RM 61.0. Additionally, since its construction in the early 1960s, HHD at RM 64.5 has been a barrier to the upstream migration of coho salmon into the upper Green River watershed. Coho salmon are mainstem and tributary spawners. There are 49 miles of mainstem and tributary habitat in the upper Green River watershed (above HHD) that are suitable for coho spawning (i.e., total mileage for all stream and mainstem sections of 3 percent or less gradient).

Adult coho salmon will be reintroduced into the upper Green River watershed above HHD following the installation of a permanent fish collection and transport facility at the Headworks. Coho salmon will be reintroduced into the upper Green River watershed using the same methods applied to chinook salmon. Since the upper watershed contains more than 40 percent of the historic anadromous stream reaches, restoring anadromous fish access to the upper watershed significantly increases the availability of suitable habitat for coho salmon in the Green River basin. The potential benefits to coho salmon production are even greater than those for chinook salmon because coho salmon can potentially spawn in a wider variety of mainstem and tributary habitats (i.e., higher gradient reaches) than can chinook salmon. Resource agencies and Tribes also believe coho salmon are more likely than chinook to establish naturally reproducing, self-sustaining runs above HHD.

There are approximately 220 square miles of watershed area and 66 miles of stream and river habitat in the upper watershed that were historically used by salmon and steelhead. Approximately 49 miles of this habitat have been estimated to be accessible and suitable for coho salmon spawning (USACE 1998, Appendix F1). Comparing the upper watershed adult coho escapement goal, estimated by the USACE (1998, Appendix F1), to the Tribal and state escapement goals for the middle and lower Green River and Newaukum Creek (WDFW et al. 1994) suggests that the upper watershed represents about 43 percent of coho habitat potentially available in the Green/Duwamish basin.

(2) Watershed Management. Watershed management activities will impact coho upstream migration in a manner similar to that described for chinook. Implementation of upland forest and riparian conservation measures will have a positive effect on coho upstream migration in the Upper HCP Area. Mass-wasting prescriptions developed through watershed analysis are expected to reduce management-related contributions of coarse sediment. Over the long-term, this could reduce the extent of aggraded reaches that consistently experience subsurface flows during dry summers. Reestablishment of riparian forests dominated by coniferous trees greater than 50 years old will increase shade, moderating elevated summer temperatures caused by lack of adequate shade. These measures will be somewhat less beneficial for coho than chinook because they move upstream later in the fall when flows are generally higher and temperatures are lower. Increasing the proportion of riparian stands greater than 50 years of age from 27 to 100 percent will result in a gradual increase in the recruitment of LWD. In addition, the increased abundance of late-seral stands is expected to ensure that at least some of the LWD that enters the stream system is large enough to function as key pieces, which are especially important for forming pools and providing cover in larger channels.

Stream crossing culverts on Tacoma's land will be inventoried, and if necessary, repaired or replaced within 5 years of issuance of the ITP. Stream crossings will be maintained in passable condition for the duration of the ITP. This measure could increase the amount of habitat that is accessible to upstream migrating coho, although the magnitude of that increase cannot be estimated until the inventory is complete.

b. Middle Watershed

(1) Water Withdrawal. Analysis of transect and stage-discharge data collected by Ecology (Caldwell and Hirschey 1989) at shallow riffles in the middle Green River indicates that passage for adult chinook salmon should not be impeded by flows greater than 225 cfs (assuming a minimum passage depth of 1.0 feet). The upstream passage of coho salmon, which have a shallower passage depth requirement (0.6 feet), should also not be impeded.

The MIT/TPU Agreement requires minimum flows greater than 225 cfs at the Auburn gage from 15 July to 15 September during all years. The SDWR is conditioned on maintaining a minimum flow of 400 cfs at Auburn gage throughout the rest of the coho upstream migration period. Because these minimum flows satisfy the upstream passage requirements of chinook salmon, they will also satisfy the upstream passage requirement of coho salmon.

(2) Watershed Management. Tacoma's watershed management activities and conservation measures will not affect coho upstream migration in the middle watershed.

c. Lower Watershed

(1) Water Withdrawal. Tacoma's water withdrawals will influence coho salmon less than chinook salmon, since coho salmon can migrate upstream through shallower areas than can fall chinook salmon (the minimum depth of passage for coho is 0.6 feet [Laufle et al. 1986]). Moreover, coho initiate upstream migration and spawning about one month later than chinook salmon in the Green River, with coho spawning continuing through mid-January (Grette and Salo 1986).

Because water depths in the lower river are sufficient for upstream passage of chinook salmon when flows at the Auburn gage exceed 200 cfs, Tacoma's water withdrawals are not expected to impede the upstream passage of coho salmon in the lower Green River. Due to their later migration and spawning period, warm water temperatures and low DO concentrations in the lower Green River have less of an influence on the upstream migration of coho salmon when compared to chinook salmon. Adult coho salmon typically move into rivers and streams following fall freshets or increased seasonal flows. These flow events have a much higher probability of occurring during the migration period (September through mid-January) of coho salmon when compared to that of chinook salmon (July through November). For this reason, Tacoma's water withdrawals will have less of an effect on the upstream migration of coho salmon than on chinook salmon.

The MIT/TPU Agreement requires minimum flows of at least 250 cfs at the Auburn gage from 15 July to 15 September during all but drought years, when minimum flows may be reduced to 225 cfs. Tacoma will not use the SDWR if instream flows at Auburn fall below 400 cfs during the remainder of the year. These minimum instream flow requirements provide adequate water depths for the upstream passage of coho salmon through the remainder of the year. Some delay may occur during sustained low flow periods early in the migration period due to poor water quality conditions and lack of migration cues, though these conditions will have less of an impact on coho salmon than on chinook salmon.

The AWS project includes a provision for the optional annual storage of up to 5,000 ac-ft of water to be used for fisheries purposes. Under dry year or drought conditions, any storage targeted to augment flows or provide a freshet in the late summer and early fall for adult chinook salmon migration and holding will also benefit coho salmon (though coho are less likely to be impacted by these conditions). The instream flows contained in the MIT/TPU Agreement should be sufficient for upstream coho salmon passage, but under the adaptive management strategy, the opportunity exists to adjust releases to meet unanticipated fisheries needs.

(2) Watershed Management. Tacoma's watershed management activities and conservation measures will not affect coho upstream migration in the lower watershed.

7. <u>Coho Salmon - Downstream Migration</u>

a. Upper Watershed

(1) Water Withdrawal. Tacoma's water withdrawals primarily affect the downstream passage of juvenile coho salmon in the Green River below the Headworks diversion facility (including the diversion dam and pool). Consequently, Tacoma's water supply diversions will have little direct impact on downstream migration in the upper watershed. Effects of water storage are addressed as a USACE activity under Section 7 of the ESA.

Since active pumping of the North Fork well field may reduce surface flow in the North Fork of the Green River above HHD, groundwater withdrawals could affect the downstream migration of juvenile coho salmon. The North Fork well field is used during periods of high turbidity in the mainstem Green River that typically occur during periods of high surface flow in the North Fork. Use of the well field during the spring outmigration season is assumed to have minimal effects on outmigrating coho juveniles.

While the USACE is responsible for the effects of water storage and release at HHD, Tacoma will be the local sponsor of the downstream fish passage facility to be installed at HHD. The operation of this facility is important to maintain high levels of coho salmon smolt survival through Howard Hanson Reservoir and Dam following re-introduction of this species into the upper Green River. The estimated coho salmon survival rate for combined reservoir and dam passage resulting under operation of the HHD fish passage facility is 87.5 percent, compared to a survival rate of 20 percent under pre-AWS project conditions (USACE 1998, Appendix F1, Section 8E).

(2) Watershed Management. Tacoma's watershed management activities and conservation measures will not affect coho downstream migration in the upper watershed.

b. Middle and Lower Watershed

(1) Water Withdrawal. Tacoma's water withdrawals will have two impacts on the survival of outmigrating juvenile coho salmon in the middle and lower watershed. First, some of the outmigrating juveniles passing through the Headworks diversion pool could be impinged on the existing screens or entrained into the water intake at the diversion. Fish impinged on the screens or entrained into the water supply system are assumed to ultimately perish. Existing screens at the Headworks do not meet NMFS design criteria, and data on existing outmigrant entrainment and survival are not available.

Second, the survival of outmigrating coho salmon in the middle and lower Green River below the Headworks is assumed to be related to the timing and volume of flow. Like juvenile chinook salmon, Tacoma's diversions are expected to result in decreased outmigrant survival values of juvenile coho salmon by reducing flows in the Green River below Headworks.

In order to quantify the impact of Tacoma's diversions on the survival of outmigrating coho salmon, daily estimates of survival conditions were calculated for proposed Green River flows under the HCP (Green River flows with the AWS project and with Tacoma withdrawals) and compared to Green River flows without the AWS project and without Tacoma withdrawals.

Coho outmigrant survival condition was estimated for each of these flow conditions using the same method used for chinook salmon (Wetherall 1971); daily survival rates were estimated during the coho salmon outmigration period (1 April through 30 June).

The results of this analysis indicate that the flow reductions below the Headworks caused by diversions under the FDWRC and SDWR result in an estimated average reduction in coho smolt survival of 4.9 percent. Estimated reductions in yearly outmigrant survival values ranged from 1.2 to 7.2 percent for the 1964-1995 period.

Tacoma will install a downstream fish bypass facility at the Headworks at RM 61.0 that includes a 220-ft- by 24-ft conventional screen. This conservation measure will improve the survival of outmigrating coho smolts passing Tacoma's Headworks by preventing fish from being impinged or entrained into the water supply intake. Upgrading the existing Headworks screens to meet NMFS design criteria is assumed to improve coho smolt survival.

Flow augmentation in May and June resulting from implementation of the AWS project will also improve the survival of outmigrating coho salmon in the Green River. Because the period of spring flow augmentation under the AWS project occurs during the peak coho salmon outmigration period (i.e., mid-April through mid-June), this measure is expected to improve outmigrant survival. The benefits to coho salmon migrants provided by AWS project spring flow augmentation measures were estimated using the same method (Wetherall 1971) used for juvenile chinook salmon. The average improvement in juvenile coho outmigrant survival resulting from the AWS project will be 3.3 percent. Estimated increases in yearly survival values resulting from the implementation of this measure range from 0.5 percent to 5.7 percent for the 1964-1995 period.

(2) Watershed Management. Tacoma's watershed management activities and conservation measures will not affect coho downstream migration in the lower and middle watershed.

8. <u>Coho Salmon - Spawning and Incubation</u>

a. Upper Watershed

(1) Water Withdrawal. Like chinook salmon, spawning habitat and incubation of coho salmon in the upper Green River basin above HHD will not be affected by Tacoma's water withdrawals at the Headworks. Pumping of groundwater from the North Fork well field, however, could affect coho salmon spawning and incubation in the North Fork of the Green River. Adult coho transported upstream past the Headworks and HHD may not find suitable spawning habitat in the North Fork until fall rains increase surface flow in the North Fork. Since pumping of the North Fork well field typically occurs with the onset of fall rains, effects on coho spawning and incubation should be minor.

As previously mentioned, the upper Green River watershed will be opened up to spawning and rearing of coho salmon through the use of an upstream trap-and-haul facility to be installed at the

Headworks. Coho salmon are expected to spawn mainly in the lower to moderate gradients (3 percent or less) of mainstem and tributary reaches within the upper watershed (USACE 1998, Appendix F1, Section 2). The USACE estimated there are 49 miles of mainstem and tributary coho spawning habitat in the upper Green River watershed that are accessible to upstream migrants and that have channel gradients of 3 percent and less (USACE 1998, Appendix F1, Section 2). The USACE estimated an escapement value of 6,500 adult coho spawners for these 49 miles of upper Green River habitat, and calculated that this added habitat area could potentially produce 161,000 coho smolts. Habitat rehabilitation projects implemented under this HCP, including placement of LWD and reconnection of side channels, are expected to increase the amount of available coho spawning habitat.

(2) Watershed Management. Potential impacts to coho spawning habitat resulting from Tacoma's watershed management activities are expected to be similar to those described for chinook. Implementation of watershed management conservation measures will have a positive effect on salmonid spawning and incubation in the Upper HCP Area. Mass-wasting prescriptions and the RSRP developed through watershed analysis is expected to reduce management-related contributions of fine sediment to less than 50 percent over background. This may result in a decrease in the proportion of fine sediment contained by spawning gravels, and could result in increased survival to emergence. Species such as coho that spawn in low gradient reaches prone to deposition of fine sediment will benefit most from improved gravel quality.

Reestablishment of riparian forests dominated by coniferous trees greater than 50 years old will result in a gradual increase in the recruitment of LWD. The net result should be an increase in in-channel LWD and an associated increase in the availability of spawning gravel. Coho in particular will benefit from increased spawning gravel availability in small, moderate gradient tributary streams.

b. Middle Watershed

(1) Water Withdrawal. Tacoma's water withdrawals will affect the availability of coho spawning habitat in both the mainstem river and side channel areas of the middle Green River in ways similar to the effects on chinook salmon. The side channels in this section of the river provide important habitat for salmon spawning, incubation, and juvenile rearing (Fuerstenberg et al. 1996; USACE 1998, Appendix F1, Section 7). Reduced flows may also increase the susceptibility of coho salmon redds to dewatering by exposing mainstem and side channel areas during the incubation period.

The potential effects of Tacoma's withdrawals on mainstem coho salmon spawning habitat in the middle Green River were quantified using the same method applied to chinook salmon (i.e., based upon Ecology's Green River IFIM study). The daily potential habitat values occurring during the spawning period of coho salmon under Green River flows with Tacoma withdrawals and Green River flows without Tacoma withdrawals were calculated using potential habitat and flow functions developed for the Green River for coho salmon by Ecology (Caldwell and

Hirschey 1989). Based on this analysis, potential coho salmon spawning habitat in the main channel of the middle Green River is increased by an average of 9.4 percent by exercise of the FDWRC and SDWR over the 32-year period of daily flows. The only annual decrease in spawning habitat caused by the diversions (-3.7 percent) was predicted during 1987, a drought year. Results of Ecology's IFIM study predicted that flows between 240 and 375 cfs provide optimal spawning habitat for coho salmon in the middle Green River. Because flows in the Green River exceed this optimal range of flows throughout much of the mid-September through mid-January spawning period of coho salmon, Tacoma's withdrawals were predicted to result in an overall improvement in spawning conditions in the middle Green River.

The potential effects of Tacoma's water withdrawals on coho spawning habitat area in the side channels of the middle Green River were quantified using wetted side channel area and discharge relationships. The same method used for estimating chinook salmon spawning habitat area in the side channels was applied to coho salmon. Values of side channel habitat were calculated on a daily basis for the coho salmon spawning period (15 September through 15 January). The results of these analyses indicate that Tacoma's withdrawals will reduce the wetted area of side channels in the middle Green River (both segments combined) by an average of 12.3 percent during the 1964-1995 period. This represents a 1.6-acre reduction in the average wetted area of side channels in the middle Green River during the coho spawning period.

The potential impacts of Tacoma's FDWRC and SDWR withdrawals on coho salmon incubation in the mainstem channel were assessed by calculating the width of the channel subject to redd dewatering (i.e., dewatered spawnable width). The same method and the same Neal Bridge transect (No. 4) from Ecology's instream flow study (Caldwell and Hirschey 1989) used to assess chinook spawning and incubation was used for coho. Spawnable and dewatered channel widths were calculated on a daily basis for the mid-September through mid-January coho spawning period assuming a 90-day incubation period.

Coho redds constructed during periods of high flow are susceptible to dewatering while redds constructed when Green River flows are low have a higher chance of remaining wetted throughout the incubation period. However, coho spawning during periods of low flow may construct redds near the center of the channel that are more susceptible to destruction by bed movement during flood events. The analysis of spawning and incubation identified potential loss of redds due to dewatering, but did not address redd destruction due to flood events.

Using Ecology's instream flow data, the average spawnable width of the mainstem river channel during the coho spawning period was predicted to be 137.6 feet without Tacoma withdrawals, and 136.4 with Tacoma water withdrawals. In the absence of Tacoma's water withdrawals, an average of 5.3 feet of the spawnable channel width was subject to potential dewatering. Tacoma's water withdrawals were predicted to potentially dewater 5.6 feet of the spawnable channel width. These values only consider the number of days within the 90-day incubation period when potential redd dewatering was predicted to occur. On the majority of days when coho spawning could occur, the redds will be protected throughout the 90-day incubation period.

The potential impacts of Tacoma's water withdrawals on coho incubation habitat in the side channels of the middle Green River were assessed using the side channel habitat area and discharge curves developed by the USACE (1998). Effects of the diversions on coho incubation habitat were quantified using the same method used for chinook salmon. The results of this analysis indicated that Tacoma's diversions will reduce side channel habitat between RM 61.0 and RM 33.8 by an average of 1.5 acres (i.e., loss of 17.3 percent) from that occurring without the diversions.

The fish collection and transportation facility at Tacoma's Headworks will substantially increase the availability of coho salmon spawning habitat in the Green River basin, and will open up an additional 49 miles of mainstem and tributary habitat suitable for coho salmon in the upper Green River. The gravel-nourishment conservation measure will also benefit coho spawning habitat conditions in the middle Green River by augmenting gravel recruitment lost from the upper watershed due to HHD. Reconnection and rehabilitation of side channels will improve spawning habitat conditions by providing up to 3.4 acres of side channel habitat in the middle Green River.

The early reservoir refill, spring flow augmentation, and freshets proposed as part of the AWS project will have little effect on coho spawning and incubation. These mitigation measures will affect flows in the Green River from late February to June, and will subsequently have no impact on coho salmon spawning that extends from mid-September through mid-January. The AWS project is predicted to have little effect on coho salmon incubation; the average increase in dewatered width predicted to occur due to the AWS project is 0.30 feet.

(2) Watershed Management. Tacoma's watershed management activities and conservation measures will not affect coho spawning and incubation in the middle watershed.

c. Lower Watershed

(1) Water Withdrawal. Due to extensive channelization, spawning habitat for coho salmon is relatively poor in the lower Green River watershed compared to that in the middle watershed. Potential coho spawning habitat and discharge relationships obtained for the Kent Site of the Ecology instream flow study (Caldwell and Hirschey 1989) were used to quantify the impacts to coho salmon spawning habitat in the lower Green River. Tacoma's water withdrawals were found to potentially increase coho spawning habitat in the lower Green River by an average of 12.2 percent. This estimate applies to main channel habitat only; there are few side channels of significant size in the lower Green River due to the presence of flood control dikes and levees along most of the lower river.

The most important conservation measures for increasing coho salmon spawning habitat in the Green River are the fish passage facilities, which will enable coho salmon to be re-introduced to the upper watershed to spawn naturally. The construction and operation of the facilities will add 49 miles of high quality spawning habitat for coho salmon in the upper Green River watershed to the habitat currently existing in the lower and middle Green River. The opportunities for improving spawning habitat in the lower Green River are very limited due to the disturbed condition of the river channel, which has been modified for flood control purposes.

The early reservoir refill, spring flow augmentation, and freshets proposed as part of the AWS project will have little effect on coho spawning and incubation in the lower Green River for the same reasons described previously for the middle Green River. Impacts of the AWS project on coho salmon incubation in the lower Green River are expected to be minor, since the channel in this section of the river is narrower than that in the middle Green River due to channelization (i.e., the outer margins of the channel subject to dewatering are very small relative to the total wetted width). As stated previously, the lower Green River provides poor spawning and incubation habitat relative to that found in the middle Green River due to extensive physical habitat disturbance.

(2) Watershed Management. Tacoma's watershed management activities and conservation measures will not affect coho spawning and incubation in the lower watershed.

9. <u>Coho Salmon - Juvenile Rearing</u>

a. Upper Watershed

(1) Water Withdrawal. Tacoma's water withdrawals will primarily affect juvenile coho habitat in the lower and middle Green River (i.e., below Headworks). Pumping of groundwater from the North Fork well field is expected to have a minor effect on coho rearing in the North Fork Green River since well field pumping primarily occurs during periods of high turbidity during the late fall, winter and early spring. Rapid flow increases in the winter flow are largely responsible for the elevated turbidity levels that necessitate the use of the groundwater pumping facility. Pumping during the summer and early fall, though rare, is expected to have a negative effect on coho salmon rearing habitat in the North Fork once this species is reintroduced into the upper watershed. Most coho salmon juveniles are expected to rear in the upper watershed for at least one year.

The trap-and-haul facility to be built by Tacoma will allow adult coho salmon that reach the Headworks diversion structure to be captured and then released into the upper watershed above HHD. In addition to reconnecting the upper watershed to the lower watershed using the trap-and-haul and downstream fish passage facilities, habitat rehabilitation projects will also be implemented by Tacoma and the USACE in the upper watershed during Phase I of the AWS project. As described in Chapter 7.1.4.1 of the HCP, the rehabilitation projects to be implemented as part of the AWS project will provide increased rearing and overwintering habitat for anadromous and resident salmonids, including juvenile coho salmon. These rehabilitation projects include creation and placement of LWD in 2.4 acres of off-channel habitat, and placement of LWD in over 4 miles of mainstem and tributary habitat. As described earlier, projects implemented as mitigation for the AWS project include placement of LWD into an additional 11.5 miles of mainstem and tributary habitat, and creation of 1.1 acres of off-channel habitat in the seasonally inundated zone. Additional off-channel areas and increased LWD loadings will provide high quality habitat for juvenile coho salmon, which prefer off-channel habitats or pools with abundant LWD cover.

(2) Watershed Management. Coho prefer low velocity pools with abundant LWD cover in the summer and seek out small, low energy tributaries; deep, slow pools; or groundwater-fed off-channel habitat. LWD may be particularly important for providing cover and refuge from high flows in larger channels. The potential affect of Tacoma's forest harvest and road building activities on juvenile coho are similar to those previously described for chinook.

Implementation of watershed management conservation measures will have a positive effect on juvenile coho rearing in the Upper HCP Area. Mass-wasting prescriptions are expected to reduce the frequency of landslides that deliver sediment and initiate dam break floods. Management-related contributions of fine sediment will be reduced to less than 50 percent over background under the RSRP. These measures are expected to result in a decrease in embeddedness and may increase the number and size of pools in small, low gradient tributaries.

Reestablishment of riparian forests dominated by coniferous trees greater than 50 years old will result in a gradual increase in the recruitment of LWD. As in-channel LWD increases, the frequency of pools is also expected to increase. Hiding cover will also improve as a result of the additional LWD. The net result should be an increase in the quality and quantity of pool habitat used for summer and winter rearing by coho. As riparian stands mature, the number of large conifers capable of acting as barrier tress during dam-break floods will increase. The increased abundance of barrier trees, combined with the decreased frequency of mass wasting is expected to reduce the risk of dam-break floods.

Stream crossing culverts on Tacoma's lands will be inventoried and repaired or replaced within 5 years of issuance of the ITP. Stream crossings will be maintained in passable condition for the duration of the ITP. This measure will increase the amount of small tributary and off-channel habitat that are accessible to coho for use as off-channel rearing habitat, although the magnitude of that increase cannot be estimated until the inventory is complete.

b. Middle Watershed

(1) Water Withdrawal. Tacoma's water withdrawals will affect coho salmon rearing habitat by reducing flows in the Green River below the Headworks by up to 213 cfs on a daily basis. The withdrawals likely will have a greater effect on coho salmon compared to chinook salmon, since most juvenile coho reside in the Green River for at least one year prior to migrating to the ocean. These withdrawals will affect coho salmon rearing in both the main river channel and side channels present along the middle Green River. These side channel areas may be particularly important rearing areas for juvenile coho salmon, which prefer off-channel habitats having abundant cover (e.g., overhanging vegetation, LWD).

The potential effects of Tacoma's withdrawals on mainstem habitat were quantified using IFIM potential habitat area and flow functions developed for juvenile coho salmon in the middle Green

River by Ecology. Daily habitat values occurring under proposed HCP conditions (Green River flows with the AWS project and with Tacoma withdrawals) were compared to those occurring under Green River flows without the AWS project and without Tacoma withdrawals. The analysis indicated that Tacoma's withdrawals (both FDWRC and SDWR) will result in an average 10.2 percent increase in juvenile coho salmon habitat in the mainstem middle Green River. Flows in the mainstem middle Green River are usually higher than those considered to be optimal for juvenile coho salmon by the Ecology instream flow study (Caldwell and Hirschey 1989). Consequently, Tacoma's withdrawals were found to have a potentially positive net effect on coho salmon rearing habitat in the main channel of the middle Green River.

One problem with Ecology's instream flow analysis, identified by state and Tribal fisheries biologists, is that it did not consider the relative importance of mainstem channel margin habitats to juvenile coho salmon. These margin areas generally possess the slow currents and cover types (woody debris or overhanging vegetation) that provide the highest quality habitat to rearing coho in many rivers and streams. Potential reductions in the wetted width in the mainstem middle Green River channel resulting from Tacoma's withdrawals were estimated to average 7.5 feet (3.25 feet per side) during summer low flow conditions (i.e., 250 cfs baseflow at Auburn). This reduction in channel width could result in some reduction in the amount of margin habitat available to coho salmon in the mainstem channel of the middle Green River.

The potential effects of Tacoma's water withdrawals on coho rearing habitat in the side channels of the middle Green River were quantified using the same wetted side channel area versus discharge relationships employed in the chinook salmon analysis. Changes in availability of side channel area were calculated on a year-round basis, since most coho salmon reside in the Green River at least one year. The results of this modeling effort predicted an average 12.6 percent reduction in total wetted area for the side channels located between RM 61.0 and RM 33.8 (i.e., majority of side channels in the Green River below HHD) during the year-round coho rearing period. This represents a 1.6-acre reduction in the wetted area of side channels in the middle Green River during the coho salmon rearing period.

The conservation measures designed to improve juvenile coho salmon habitat are the same as those described to improve juvenile chinook habitat in the middle Green River. These measures include reconnecting and restoring the Signani Slough side channel, and placement of LWD in the river channel. These measures will improve coho salmon rearing habitat by providing up to 3.4 acres of additional off-channel habitat, which is important for overwintering, and by increasing the structural complexity of main channel habitats. As mentioned previously, LWD provides important cover habitat to juvenile coho salmon.

As described for chinook salmon, some benefits will also be realized for several miles of the Green River below HHD by improving (decreasing) water temperatures for salmonids. Temperature modeling results indicated that the natural inflow to HHD exceeds the state Class "AA" temperature standard of 16.0˚C during the summer and early fall of most years. Water temperature modeling results for the AWS project suggest that water released from HHD will exceed this temperature in only one of 33 years. The preferred fish passage alternative under the

AWS project has a 97 percent reliability for maintaining HHD release temperatures below the state standard. By the time the water reaches the downstream end of the Palmer spawning reach (RM 61.0-58.0), this benefit will progressively diminish as stream temperatures approach equilibrium conditions with the air temperatures.

(2) Watershed Management. Tacoma's watershed management activities and conservation measures will not affect coho juvenile rearing in the middle watershed.

c. Lower Watershed

(1) Water Withdrawal. As with the middle Green River, flow reductions resulting from the FDWRC and SDWR will improve mainstem habitat conditions for juvenile coho salmon in the lower Green River but reduce availability of side channel habitats. Municipal water withdrawals modeled using daily flows from 1964-1995 for the lower river resulted in an average 15.1 percent increase in mainstem habitat for juvenile coho salmon. Improvements in mainstem juvenile habitat area resulting from the water supply diversions occur because flows in the lower Green River are usually higher than the flow considered to be optimal for juvenile coho salmon by Ecology's instream flow study. Because the lower river has been extensively channelized, the wetted width of the mainstem channel will not significantly change (2.3-feet reduction in total width; 1.15 feet per side) during summer low flow periods (i.e., 250 cfs at Auburn) as a result of the municipal water withdrawals. Impacts to mainstem channel margin habitat will therefore be minor. Since there is little off-channel habitat in the lower Green River due to channelization and flood control, impacts of municipal water withdrawals to off-channel habitat will be small.

As described for chinook salmon, water quality problems within the lower Green River include water temperature, DO, nutrient enrichment, and a variety of pollutants. However, the effects of HHD and Tacoma's water withdrawal activities will not extend sufficiently far downstream to significantly affect water quality conditions (particularly temperature) in the lower Green and Duwamish rivers.

Juvenile coho salmon habitat is generally poor in the lower Green River as a result of channelization for flood control. For this reason, mitigation measures for juvenile coho salmon, like chinook salmon, focus on habitat enhancement of the upper and middle Green River, including LWD placement and side channel restoration.

The implementation of freshets during fall low flow conditions, if included as part of the optional storage of 5,000 ac-ft for low flow augmentation, could potentially provide short-term improvements in water quality conditions in the lower Green River to induce and improve upstream passage of adult coho and chinook salmon. However, these freshets will not be sufficient in duration to provide tangible benefits to rearing salmon and steelhead.

(2) Watershed Management. Tacoma's watershed management activities and conservation measures will not affect coho juvenile rearing in the lower watershed.

10. Sockeye Salmon - Upstream Migration

a. Upper Watershed

We assume that sockeye salmon will not be introduced into the upper Green River watershed and therefore neither Tacoma's water withdrawal or watershed management activities, and associated conservation measures will affect sockeye salmon in that segment of the river.

b. *Middle Watershed*

(1) Water Withdrawal. Analysis of transect data (Caldwell and Hirschey 1989) collected in the middle Green River indicated that passage of chinook salmon should not be impeded when flows are greater than 225 cfs (assuming a minimum passage depth of 1.0 feet). As noted above, the minimum passage depth of sockeye salmon is less (0.6 feet) than for chinook and, therefore, passage through the middle Green River at flows greater than 225 cfs should not be impeded. With respect to holding habitat, the water quality conditions in the middle Green River should be better than those in the lower river during the entire period (June through August) in which sockeye are entering and holding within the system. This is because the upper portions of the middle river are more proximal to HHD and therefore still benefit from the cooler water releases from the HHD Reservoir. In addition, the relatively steep gradients and coarse substrate typical of the channel in the Green River Gorge increase surface turbulence and promote aeration of the water. Thus, there should be no water quality-related impacts on holding adult sockeye salmon, nor delays in their migration resulting from Tacoma's water withdrawals.

The minimum flows specified under the MIT/TPU Agreement satisfy the upstream passage requirements of chinook salmon and therefore will also satisfy the upstream passage needs of sockeye salmon.

The AWS project provision of an optional annual storage of up to 5,000 ac-ft for fisheries purposes, which could be used for freshets in the late summer and early fall (as described for chinook and coho salmon), will also provide some benefits to sockeye salmon.

(2) Watershed Management. Tacoma's watershed management activities and conservation measures will not affect sockeye upstream migration in the middle watershed.

c. Lower Watershed

(1) Water Withdrawal. According to Gustafson et al. (1997), Puget Sound sockeye enter streams beginning in mid-June through August, although the actual timing when sockeye enter the Green River is unknown. Adult sockeye that enter the system early (e.g., in June/early July) will likely migrate upstream until they find suitable pools and pocket water, where they may hold for several months until ready to spawn. The quantity and quality of flow in the lower Green River in June and July should be conducive to sockeye entering, migrating, and holding within the system. Presumably, fish from the early part of the run migrate upstream to deep pools and holding waters associated with or upstream from the Green River Gorge. Given the proximity to HHD, the presence of a natural riparian zone, and the steep gradient of the channel (resulting in surface turbulence and aeration of the water), the water quality (temperature and DO concentrations) within the area of the Green River Gorge is likely to be much better than conditions in the lower river during the late summer and early fall. Indeed, sockeye entering the lower Green River in late July and August may be subjected to low streamflow and water quality problems related directly to elevated water temperatures and low DO concentrations. This period partially corresponds to the migration period of chinook salmon, and therefore the analysis completed for chinook has applicability for sockeye in the lower river. Thus, there could be some delay in the initial passage of sockeye salmon into the lower Green River and Duwamish Estuary during periods of low flow and degraded water quality conditions. However, such conditions will likely be transitory, and as noted by Fujioka (1970) for chinook, and not prevent the ultimate migration of sockeye into the system.

With respect to the actual physical ability of sockeye to migrate through the lower Green River, the analysis of transects completed for chinook salmon indicated that suitable passage flows for chinook salmon will be achieved when flows at the Auburn gage exceed 200 cfs. Because sockeye are smaller than chinook and able to pass upstream through shallow water, passage conditions suitable for chinook will likewise be sufficient for sockeye. Bell (1986) listed a minimum passage depth of 0.6 feet for upstream migration of sockeye salmon.

As noted for coho, the MIT/TPU Agreement requires minimum flows of at least 250 cfs at the Auburn gage from 15 July to 15 September during all but drought years, when minimum flows may be reduced to 225 cfs. Tacoma will not use the SDWR if instream flows at Palmer fall below 300 cfs during the remainder of the year. These minimum instream flow requirements during the fall and early winter migration period for sockeye salmon will result in flows that provide adequate water depths for the upstream passage of sockeye salmon through the lower watershed. Depending on the actual run-timing of Green River sockeye, some delay in migration could occur early in the migration period (late June/early July) during sustained low flows due to poor water quality conditions and lack of migration cues. However, such delays will be transitory and will not result in any mortality to the adult salmon; the delay will likely result in the adult fish remaining in salt-water/estuarine habitats for a longer time until suitable flow conditions occurred in the Green River in which to stimulate upstream migration.

The AWS project provision of an optional annual storage of up to 5,000 ac-ft for fisheries purposes, which could be used for freshets in the late summer and early fall (as described for chinook and coho salmon, will also provide some benefit to sockeye salmon.

(2) Watershed Management. Tacoma's watershed management activities and conservation measures will not affect sockeye upstream migration in the lower watershed.

11. Sockeye Salmon - Downstream Migration

a. *Upper Watershed*

It is assumed that sockeye salmon will not be introduced into the upper Green River watershed and therefore Tacoma's water withdrawal, watershed management activities, and associated conservation measures will not affect sockeye salmon in that segment of the river.

b. Middle and Lower Watershed

(1) Water Withdrawal. Because sockeye salmon will not be introduced above HHD and adults will not be placed above the Headworks, there is no potential entrainment or impingement of sockeye juveniles at the Headworks diversion.

However, as noted for coho, the survival of outmigrating sockeye salmon in the middle and lower Green River below the Headworks is assumed to be a function of flow, and thus will be influenced by Tacoma's flow diversions. Because of similarities in outmigration timing of smolts between coho (April through June) and sockeye (April through May) (Table C-5 in Gustafson et al. 1997) the instream migration analysis computed for coho should be applicable for approximating anticipated impacts of water diversions on sockeye downstream migration. The results of that analysis indicated an average annual reduction in coho smolt survival condition of 4.9 percent, with reductions in yearly outmigrant survival values ranging from 1.2 percent to 7.2 percent for the period 1964-1995. Reductions in sockeye outmigration survival condition are anticipated to be similar to coho.

The flow augmentation measures occurring in May and June associated with the implementation of the AWS project will increase survival of outmigrating sockeye salmon in the middle and lower sections of the Green River. The degree of benefit is assumed to be similar to that determined for coho salmon, an average increase in survival condition of 3.3 percent.

12. <u>Sockeye Salmon - Spawning and Incubation</u>

a. *Upper Watershed*

It is assumed that sockeye salmon will not be introduced into the upper Green River watershed and therefore Tacoma's water withdrawal, watershed management activities, and associated conservation measures will not affect sockeye salmon spawning and incubation in that segment of the river.

b. *Middle Watershed*

(1) Water Withdrawal. As for coho and chinook, Tacoma's water withdrawals will affect the availability of sockeye spawning habitat in both the mainstem river and side channel areas of the middle Green River. The effects of such withdrawals on sockeye salmon spawning and incubation can be approximated by using the analysis completed for coho salmon, assuming similarity in habitat requirements between the two species. Separate analyses were completed for mainstem and off-channel spawning and incubation habitats.

For the mainstem, the analysis indicated an average increase of potential spawning habitat of over 9 percent when the FDWRC and SDWR withdrawals are operating; the greatest reduction (-3.7 percent) in habitat was predicted to occur under drought conditions in 1987. The increases in habitat ascribed to Tacoma's withdrawal of water are a function of the habitat and flow relationships that have been predicted for coho salmon for that section of the river. The relationships indicate that optimal spawning habitat is provided at flows between 240 and 375 cfs. Because natural flows that occur during the period of coho and sockeye spawning generally exceed those values, the withdrawal of water by Tacoma will result in an overall increase in the amount of potential spawning habitat under those conditions.

The effect of Tacoma's FDWRC and SDWR withdrawals on side channel spawning habitat for sockeye salmon should be similar to that on coho salmon, since both species have similar spawning periods. The analysis for coho salmon indicated that Tacoma's withdrawals will reduce the total area of side channels in the middle Green River by an average of 1.6 acres during its mid-September through mid-January spawning period. This represents a 12.3 percent reduction in the average wetted area of side channels in the middle Green River during the coho spawning period.

The potential effects of Tacoma's withdrawals on incubating eggs and embryos of sockeye salmon were also assumed to be similar to those on coho salmon. For mainstem sections of the middle Green River during the sockeye spawning period, the spawnable width of the river was calculated as 137.6 feet without the withdrawals and 136.4 feet with the withdrawals. The average dewatered spawnable width for those days when redd dewatering was predicted to occur was 5.3 feet without the withdrawals and 5.6 feet with the withdrawals. Thus, the increase in average dewatered spawnable width (i.e., the margin of the channel subject to egg/embryo mortality) due to the withdrawals is 0.3 feet. The protected spawnable width of the channel (i.e., the spawnable width not subject to dewatering) was 132.3 feet without the withdrawals and 130.8 feet with the withdrawals. The withdrawals therefore reduce the protected spawnable width of the channel by 1.5 feet.

The potential effects of the diversions on side channel incubation indicated an average reduction of 1.5 acres of side channel habitat over that occurring without the withdrawals. According to Burgner (1991), sockeye salmon tend to utilize spring-fed ponds and side channels for spawning more than any other species of salmon. Therefore, the loss of these side channel habitats could have more of an effect on sockeye salmon than other salmon species if sockeye are spawning in side channels in the Green River. However, the overall numbers of sockeye using the middle Green River for spawning is low.

Because sockeye salmon will not be introduced into the upper watershed, the effects of Tacoma's water withdrawals on sockeye salmon will not be offset by the increased availability of spawning habitats in the upper basin. However, the combined measures of gravel nourishment and the reconnection and restoration of side channel habitats at several locations in the middle Green River will benefit sockeye spawning and incubation.

(2) Watershed Management. Tacoma's watershed management activities and conservation measures will not affect sockeye salmon spawning incubation in the middle watershed.

c. *Lower Watershed*

Because of similarities in spawning and incubation timing and habitat requirements, the same analysis applied to coho salmon should be applicable to sockeye; Tacoma's water withdrawals will increase potential spawning habitat in the lower watershed by an average of 12.2 percent. The opportunities for improving spawning habitat in the lower Green River are limited due to channel modifications directed toward flood control. Even so, the results of the habitat and flow analysis noted above suggest a potential net increase in the amount of available spawning habitat with Tacoma's water withdrawals.

(1) Watershed Management. Tacoma's watershed management activities and conservation measures will not affect sockeye spawning and incubation in the lower watershed.

12. <u>Sockeye Salmon - Juvenile Rearing</u>

a. *Upper Watershed*

It is assumed that sockeye salmon will not be introduced into the upper Green River watershed and therefore Tacoma's water withdrawal, watershed management activities, and associated conservation measures will not affect sockeye salmon juvenile rearing in that segment of the river.

b. *Middle Watershed*

(1) Water Withdrawal. River-type juvenile sockeye salmon presumably will utilize similar habitat features as coho, including mainstem areas, as well as and perhaps most importantly side channel and slough habitats. Tacoma's water withdrawals will affect both habitat types. The analysis of such effects on juvenile sockeye rearing habitat was again (absent species specific data and information) based on that for coho salmon, the results of which are summarized below.

Because juvenile fish typically utilize areas of slower water velocities, the results of the habitat:flow modeling completed for coho indicated an overall increase in juvenile habitat (10.2 percent) resulting from Tacoma's water withdrawals compared to a no-diversion condition. This is because flows that are higher than those providing optimal rearing habitats are usually present in the middle watershed. Rearing habitat in mainstem rivers is often associated with channel margins that contain slow velocities and physical cover features (e.g., undercut banks, LWD) conducive to juvenile rearing. The analysis completed for coho suggested that an average of 7.5 feet (3.25 feet per side) of wetted channel will be lost during summer low flow conditions in the middle Green River, which will likely translate to reductions in channel margin habitat.

For the side channels, the coho analysis (indicated an 12.6 percent reduction (e.g., 1.6-acre reduction in wetted area) in total wetted area in the side channels located between RM 61.0 and 33.8. That segment of the Green River contains the majority of side channels below HHD. The conservation measures that will improve juvenile sockeye habitat are the same as those described for chinook and coho salmon. These measures include reconnecting and rehabilitation the Signani Slough side channel, and placement of LWD in the river channel. Some additional temperature benefits on juvenile rearing habitat will also likely result from cold water releases from HHD.

(2) Watershed Management. Tacoma's watershed management activities and conservation measures will not affect sockeye juvenile rearing in the middle watershed.

c. *Lower Watershed*

(1) Water Withdrawal. Based on the juvenile habitat:flow models developed for coho for the lower Green River, Tacoma's water withdrawals were estimated to result in an average increase in juvenile habitat of over 15 percent. Because of the channelized nature of sections of the lower Green River (for flood control purposes), reductions in wetted channel widths and off-channel habitats will be small. Water quality problems do exist in the lower Green River. However, the effects of HHD and Tacoma's water withdrawal activities will not extend sufficiently far downstream to substantially affect water quality conditions (particularly temperature) in the lower Green and Duwamish rivers.

Conservation measures for juvenile sockeye salmon will focus largely on areas in the middle sections of the Green River. Habitat quality in the lower Green River is generally poor (due to channelization for flood control), therefore the conservation measures will not affect sockeye juvenile rearing habitat in the lower watershed.

13. <u>Chum Salmon - Upstream Migration</u>

a. *Upper Watershed*

(1) Water Withdrawal. The major spawning areas for chum salmon in the Green River are the braided sections of the mainstem below the Gorge, in side channel areas of the middle Green River, and in major tributaries to the middle river including Burns, Crisp, and Newaukum creeks (Dunstan 1955; Grette and Salo 1986). Few native chum have been observed upstream of the confluence of Crisp Creek (RM 41.0) (WDFW et al. 1994). The Headworks diversion structure prevents the upstream migration of adult chum salmon above RM 61.0. However, it is unlikely that many chum migrate this far upstream based upon the results of prior studies on the distribution of spawners in the Green River basin.

Upstream passage of adult fish will be provided by a permanent fish collection and transport facility at the Tacoma Headworks. However, this upstream passage facility is not expected to benefit chum salmon, since very few chum are likely to migrate upstream as far as the

Headworks facility. The number of adult chum reintroduced into the upper watershed by the fish collection and transport program will not be sufficient to establish a self-sustaining run in the upper watershed. Moreover, survival of any outmigrating chum fry passing downstream through the HHD reservoir will likely be poor.

(2) Watershed Management. Because few chum salmon are expected to be introduced into the upper watershed, Tacoma's forest management activities and associated conservation measures will not affect chum salmon upstream migration in the upper watershed.

b. *Middle Watershed*

(1) Water Withdrawal. Analysis of transect and stage-discharge data collected by Ecology (Caldwell and Hirschey 1989) at shallow riffles in the middle Green River indicate that passage for adult chinook salmon should not be impeded by flows greater than 225 cfs (assuming a minimum passage depth of 1.0 foot). The upstream passage of chum salmon should also not be impeded, since chum can migrate through shallower areas than chinook salmon.

The MIT/TPU Agreement requires minimum flows greater than 225 cfs at the Auburn gage from July 15 to September 15 during all years. The SDWR is conditioned on maintaining a 300 cfs minimum flow at Palmer gage throughout the rest of the chum salmon upstream migration period. Because these minimum flows satisfy the upstream passage requirements of chinook salmon, they will also satisfy the upstream passage requirement of chum salmon.

(2) Watershed Management. Tacoma's watershed management activities and conservation measures will not affect chum upstream migration in the middle watershed.

c. *Lower Watershed*

(1) Water Withdrawal. Tacoma's water withdrawals will likely have less of an influence on chum salmon than chinook salmon since chum commence upstream migration and spawning almost two months later than chinook salmon in the Green River. Chum salmon migrate into the river from early September through late December, and spawn from early November through mid-January (Grette and Salo 1986). Chum migration and spawning occurs during the late fall and early winter when flows in the Green River are often high and upstream passage is less likely to be a problem.

Because water depths in the lower river are sufficient for upstream passage of chinook salmon when flows at the Auburn gage exceed 200 cfs, Tacoma's water withdrawals are not expected to impede the upstream passage of chum salmon in the lower Green River. Chum salmon have the ability to migrate into shallow, low-velocity streams and side channels (Johnson et al. 1997), and therefore have a greater ability to pass upstream through shallow areas than do chinook salmon. Due to their later migration and spawning period, warm water temperatures and low DO concentrations in the lower Green River will have less of a potential impact on the upstream migration of chum salmon than for chinook salmon.

The minimum instream flow requirements provided under the MIT/TPU Agreement during the fall and early winter migration period of chum salmon will provide adequate water depths for upstream passage through the lower watershed. Some delay may occur during sustained low flow periods early in the migration season due to poor water quality conditions and lack of migration cues, although these conditions probably occur for a short duration during the late fall and early winter migration period of chum salmon.

The AWS project includes a provision for the optional annual storage of up to 5,000 ac-ft of water to be used for fisheries purposes. Under dry year or drought conditions, any storage targeted to augment flows or provide a freshet in the late summer and early fall for adult chinook salmon migration and holding could benefit chum salmon, though chum are less likely to benefit since they migrate upstream later than chinook.

(1) Watershed Management. Tacoma's forest management activities and conservation measures will not affect chum upstream migration in the lower watershed.

14. <u>Chum Salmon - Downstream Migration</u>

a. *Upper Watershed*

(1) Water Withdrawal. Tacoma's water withdrawals will primarily affect the downstream passage of juvenile chum salmon in the Green River below the Headworks diversion facility. Tacoma's water supply diversions will probably have little impact on the downstream migration of chum salmon fry from the upper watershed, since few fry will be produced in the upper watershed.

As mentioned previously, Tacoma will be the local sponsor of the downstream fish passage facility to be installed at HHD. The operation of this facility is important to maintain high survival levels of coho salmon, chinook salmon, and steelhead smolt passing downstream through Howard Hanson Reservoir and Dam following the re-introduction of these species into the upper Green River. However, this downstream fish passage facility will provide little tangible benefit to chum salmon because it is unlikely that this species will become established in the upper watershed.

(2)Watershed Management. Because few chum salmon are expected to be introduced into the upper watershed, Tacoma's forest management activities and associated conservation measures will not affect chum salmon downstream migration in the upper watershed.

b. *Middle and Lower Watershed*

(1) Water Withdrawal. The number of chum fry passing downstream through the Headworks diversion pool that could be potentially impinged on the existing screens or entrained into the water intake at the diversion is likely to be very small, since few if any chum will be produced in the upper Green River watershed. However, reduced flows resulting from Tacoma's FDWRC and SDWR withdrawals are expected to result in decreased conditions of outmigrant survival for chum salmon fry in the Green River below Headworks at RM 61.0. As is the case for chinook salmon, the survival of downstream migrating chum salmon is assumed to be a function of flow, with survival increasing as river discharge increases.

In order to quantify the impact of Tacoma's diversions on the survival of outmigrating chum salmon, daily estimates of the condition of instream migration were calculated for proposed Green River flows under the HCP flows (Green River flows with the AWS project and with Tacoma withdrawals) compared to Green River flows without the AWS project and without Tacoma withdrawals. The survival condition of outmigrating chum fry under each flow regime was calculated on a daily basis during the chum outmigration period (16 February through 31 May) using the same method applied to chinook salmon fry.

The results of this analysis indicate that the flow reductions caused by Tacoma's water withdrawals under the FDWRC and SDWR could result in an average reduction in chum salmon fry outmigrant survival condition of 5.0 percent. Predicted reductions in yearly chum outmigrant survival values caused by these water withdrawals ranged from 2.4 percent to 7.2 percent for the 1964-1995 period.

As described earlier, Tacoma will install a downstream fish bypass facility at the Headworks at RM 61.0 that includes a 220-ft- by 24-ft conventional screen. This conservation measure will significantly improve the survival of outmigrating juvenile coho salmon, chinook salmon, and steelhead, but will not provide tangible benefits to chum salmon because very few chum fry are expected to be produced in the upper watershed.

Flows in the Green River below HHD with the proposed AWS project (i.e., early reservoir refill) will be reduced during March and April compared to the flows occurring without the AWS project. Water stored in the reservoir during this period will be used to augment flows in May and June under the proposed AWS project. Analysis of AWS project impacts on downstream migration of anadromous salmonids suggests that chum salmon are the primary salmonid species directly impacted by the early storage of water. Chum salmon are more likely to be affected by the AWS project flow measures because their peak outmigration period (March and April) coincides with the period when river flows will be reduced by these measures.

The effects of the AWS project flow measures on chum salmon outmigrant survival condition were calculated using the same method used for juvenile chinook salmon. The AWS project flow measures were predicted to result in an average reduction in yearly survival of 0.3 percent. The greatest reduction in yearly survival condition values caused by the AWS project flow measures were predicted during 1978 (-2.9 percent), while survival was predicted to be improved slightly during 1992 (1.9 percent). Flows in the Green River are relatively high during April and May, and the reductions in flow during this period resulting from the AWS project were not great enough to significantly reduce the survival of chum outmigrants.

These losses may be partially mitigated by increased survival of hatchery-reared chum fry. Assuming artificial freshets are released from HHD to maintain a flow of 2,500 cfs at Auburn for a 38-hour period during the chum outmigration period, hatchery managers could benefit instream migration conditions of hatchery-reared chum fry by releasing the fry during the planned freshets. Between 1992 and 1996, an average of 732,000 chum fry were released into the Green River from hatcheries. During this period, hatchery-reared chum fry have been released into the Green River at an average flow of 1,473 cfs, measured at Auburn. The size of fish and the date of release are dictated by considerations such as growth rate, available hatchery rearing space, general health of the fingerlings, and instream conditions during release. However, assuming that chum fry could be released during a planned freshet, the survival condition of chum fry will increase by 24.3 percent compared to 1992-1996 release conditions.

(2) Watershed Management Tacoma's forest management activities and associated conservation measures will not affect chum downstream migration in the middle and lower watershed.

15. <u>Chum Salmon - Spawning and Incubation</u>

a. *Upper Watershed*

Because few if any chum adults are expected to be introduced into the upper Green River watershed via the proposed trap-and-haul facility at Headworks, Tacoma's water withdrawals, watershed management activities, and the associated conservation measures will have no significant effects on chum spawning and incubation in the upper watershed.

b. *Middle Watershed*

(1) Water Withdrawal. Tacoma's water withdrawals will affect the availability of chum salmon spawning habitat in both the mainstem river and side channel areas of the middle Green River. The side channels in the middle Green River are probably more important to chum salmon spawning than any other anadromous fish species present in the basin. Chum salmon are more likely to spawn in shallow, low-velocity streams and side channels than other salmon species (Johnson et al. 1997). Muckleshoot Tribal biologists surveying the Green River during 1996 reported significant numbers of chum spawning in side channels of the middle Green River. The majority of chum salmon in the Green River watershed may be produced in side channels and tributaries including Newaukum, Crisp, and Burns creeks (Dunstan 1955; WDFW et al. 1994). Chum spawning and incubating in the tributaries will not be directly affected by Tacoma's withdrawals.

Flow reductions caused by Tacoma's FDWRC and SDWR withdrawals could increase the susceptibility of chum salmon redds to dewatering in the mainstem and side channel areas of the middle Green River. The potential effects of Tacoma's withdrawals on mainstem chum salmon spawning habitat in the middle Green River were quantified using the same method applied to chinook salmon (i.e., based upon Ecology's Green River IFIM study). Daily potential chum salmon spawning habitat values were calculated for Green River flows with Tacoma withdrawals, and Green River flows without Tacoma withdrawals, using habitat and flow functions developed for Green River chum salmon by Ecology (Caldwell and Hirschey 1989). Based on this analysis, potential chum salmon spawning habitat in the main channel of the middle Green River was predicted to be improved by an average of 17.8 percent during the chum salmon spawning period (1 November through 15 January) by exercise of the FDWRC and SDWR. The only decrease in chum spawning habitat resulting from municipal water withdrawals (-4.3 percent) was predicted during 1987, a drought year. In contrast, the water withdrawals were predicted to result in an 29.0 percent increase in potential spawning habitat area during 1984, an average year.

Results of Ecology's IFIM study (Caldwell and Hirschey 1989) predicted that flows between 260 and 450 cfs provide optimal spawning habitat conditions for chum salmon in the middle Green River. Because flows in the Green River exceed this optimum range throughout much of the early November through mid-January spawning period of chum salmon, Tacoma's withdrawals are predicted to result in an overall improvement in spawning conditions in the mainstem middle Green River.

As mentioned earlier, the side channels of the middle Green River may be more important than the main channel to chum salmon spawning. The potential effects of Tacoma's water withdrawals on chum salmon spawning habitat area in the side channels of the middle Green River were quantified using wetted side channel area and discharge relationships. Chum salmon spawning habitat in the side channels was quantified using the same procedure applied to chinook salmon. Side channel habitat area values were calculated on a daily basis during the chum salmon spawning period for a 32-year period (1964-1995). The results of this analysis indicates that Tacoma's water withdrawals will reduce the wetted area of side channels in the middle Green River by an average of 10.6 percent during the chum spawning period. This represents a 1.7-acre reduction in the average wetted area of side channels in the middle Green River during the chum spawning period.

The potential impacts of Tacoma's diversions on chum salmon incubation were assessed by calculating the width of the channel subject to dewatering (i.e., dewatered spawnable width) using the same method applied to chinook salmon. Dewatered channel widths were calculated on a daily basis for the chum salmon spawning period, and assumed a 90-day incubation period (i.e., time from egg deposition to fry emergence). The average spawnable width of the main river channel during the chum spawning period was predicted to be 139.8 feet without Tacoma's water withdrawals, and 138.6 feet with the water withdrawals (based upon cross-section and rating curve data obtained at Transect 4 of the Nealy Bridge IFIM site). For days when redd dewatering was predicted to occur, the dewatered spawnable width of the channel averaged 5.5 feet without Tacoma's water withdrawals and 5.8 feet with the water withdrawals. Thus, the water withdrawals are predicted to result in an average increase of 0.3 feet in the dewatered width of the channel during those days when redd dewatering is predicted to occur. This represents a very small portion of the total width of the channel (i.e., 0.14 percent) within which chum salmon can potentially spawn. The protected spawnable width of the channel (i.e., the spawnable width not subject to dewatering) was 134.3 feet without the withdrawals and 132.8 feet with the withdrawals. The withdrawals therefore reduce the protected spawnable width of the channel by 1.5 feet. The water withdrawals were not found to increase the frequency of dewatering during the 75-day incubation period chum salmon. Dewatering of some portion of the spawnable width of the channel is predicted to occur for an average of 31 days both without and with the withdrawals (i.e., 41 percent of the days in the spawning period).

The potential impacts of Tacoma's water withdrawals on chum salmon incubation in the side channels of the middle Green River were analyzed using the side channel habitat area and discharge curves developed by the USACE (1998). Effects of the diversions on incubation in the side channels were quantified on a daily basis for a 32-year period (1964-1995) using the same method applied to chinook salmon incubation. Tacoma's FDWRC and SDWR withdrawals are predicted to reduce the total area of the side channels during two-day low flow events (i.e., the event most likely to result in redd dewatering) by an average of 1.5 acres (loss of 17.3 percent) from that occurring without the water withdrawals during the incubation period of chum salmon. The gravel nourishment conservation measure will benefit chum salmon spawning habitat in the middle Green River by augmenting gravel recruitment lost from the upper watershed due to HHD. Reconnection and restoration of side channels will also improve spawning habitat conditions by providing up to 3.4 acres of additional side channel habitat in the middle Green River, an increase of approximately 22 percent over the total existing area of side channel habitat potentially available to spawning chum salmon.

The early reservoir refill, spring flow augmentation, and freshets proposed as part of the AWS project will have little effect on chum spawning habitat in the main channel and side channels. These flow measures will only modify the flow regime of the Green River between 1 March and 30 June, which is after the November through January spawning period of chum salmon. The AWS project early refill flow measures in the main channel of the middle Green River are minor, as the average increase in dewatered spawnable width predicted to result from these flow measures is 0.1 feet for days when redd dewatering is predicted to occur. The AWS project early refill measure will not result in a change in the frequency of days when dewatering occurs.

(2) Watershed Management. Tacoma's forest management activities and associated conservation measures will not affect chum spawning and incubation in the middle watershed.

c. *Lower Watershed*

(1) Water Withdrawal. Due to extensive channelization, spawning habitat for chum salmon, like that for coho and chinook salmon, is relatively poor in the lower Green River watershed compared to that in the middle watershed. Potential chum salmon spawning habitat and discharge relationships obtained for the lower Green River from Ecology's instream flow study (Caldwell and Hirschey 1989) were used to quantify the impacts of FDWRC and SDWR water withdrawals on chum salmon spawning habitat in the lower Green River. Tacoma's water withdrawals are predicted to increase potential chum spawning habitat in the lower Green River by an average of 16.2 percent for the November through January spawning period. This estimate applies to main channel habitat only, since there are few side channels of significant size in the lower Green River.

The opportunities for improving spawning habitat in the lower Green River are very limited due to the disturbed condition of the river channel, which has been extensively modified for flood control purposes. For this reason, those conservation measures that will result in improvements in chum salmon spawning habitat and incubation (e.g., reconnection and restoration of side channels) focus mainly on the middle section of the Green River.

The early reservoir refill, spring flow augmentation, and freshets proposed as part of the AWS project will have little effect on chum spawning habitat and incubation in the lower Green River for the same reasons previously described for the middle Green River. Impacts of the AWS project on chum salmon incubation in the lower Green River are expected to be fewer than those in the middle Green River (i.e., average 0.1 feet increase in dewatered spawnable width).

(2) Watershed Management. Tacoma's forest management activities and associated conservation measures will not affect chum spawning and incubation in the lower watershed.

16. <u>Chum Salmon - Juvenile Rearing</u>

a. *Upper Watershed*

Potential Effects of Covered Activities and Conservation Measures on Chum Juvenile Rearing
Tacoma's water withdrawals, watershed management activities, and associated conservation measures will not affect juvenile chum habitat in the upper Green River, since few if any chum spawners are expected to be introduced into the upper watershed as a result of the proposed trap-and-haul program at the Headworks.

b. *Middle Watershed*

(1) Water Withdrawal. Tacoma's water withdrawals potentially affect juvenile chum salmon habitat in the middle Green River by reducing flows below Headworks by up to 213 cfs on a daily basis. The withdrawals likely will have a similar effect on chum salmon as they do on chinook salmon because both species have an ocean-type life cycle (i.e., juveniles reside in the river for less than one year before migrating to the ocean). Chum salmon fry are present in the Green River from mid-March through mid-July, though most fry outmigrate to the ocean by the end of May. Chum salmon juveniles are typically not present in the drainage during the remainder of the year.

Tacoma's FDWRC and SDWR withdrawals potentially affect chum salmon rearing in both the main river channel, as well as in the side channels present along the middle Green River. The side channel areas are important to chum salmon fry, which prefer low velocity off-channel habitat areas within which to rear during their relatively short period of residency in the Green River prior to migrating to estuary areas of the Duwamish River and Elliott Bay.

The effects of Tacoma's withdrawals on chum salmon fry habitat were quantified using IFIM potential habitat area and flow functions developed for the middle Green River by Ecology. Habitat area and flow functions were not developed for chum fry as part of Ecology's instream flow study. For this reason, the functions developed by Ecology for chinook salmon juveniles in the middle Green River were used to quantify the effects of the municipal water withdrawals on chum salmon. Chinook salmon juveniles can hold in slightly faster and deeper water than chum salmon fry, so they serve as a conservative surrogate for estimating the potential influence of Tacoma's water withdrawals on this life stage.

Daily habitat values for chum fry occurring under proposed HCP conditions (Green River flows with the AWS project and with Tacoma withdrawals) were compared with those occurring under Green River flows without the AWS project and without Tacoma withdrawals for the period when chum salmon fry are present in the river (mid-February through mid-June). The analysis indicated that Tacoma's withdrawals will result in an average 11.4 percent increase in chum salmon fry habitat in the mainstem sections of the middle Green River. Flows in the middle Green River are usually higher than those considered to be optimal for juvenile chinook salmon by the Ecology instream flow study (Caldwell and Hirschey 1989); this relationship applies to chum salmon fry even to a greater extent since they prefer lower velocity waters. Consequently, Tacoma's withdrawals are expected to have a positive net effect on chum salmon rearing habitat in the main channel of the middle Green River.

As in the case of coho salmon, Tacoma's water withdrawals will likely reduce the amount of margin habitat available to chum salmon fry along the main channel of the Green River. The reductions in margin habitat area are likely to pose less of an impact to chum salmon fry in the middle Green River, since they remain in the mainstem channel for a relatively short period of time, after which they migrate to side channel areas or the estuary areas of the Duwamish River and Elliott Bay.

The potential effects of Tacoma's water withdrawals on chum salmon rearing habitat in the side channels of the middle Green River were quantified using the same wetted side channel area versus discharge relationships applied to chinook salmon fry. Changes in the availability of side channel area were calculated for the chum salmon rearing period in the Green River (mid-February through mid-June). The results of this modeling effort predicted an average 18.4 percent loss in the total wetted area of side channels in the middle Green River resulting from Tacoma's water withdrawals during the chum salmon rearing period. This represents a 1.4-acre reduction in the wetted area of side channels in the middle Green River during the chum salmon rearing period.

The habitat conservation measures intended to improve juvenile chum salmon habitat are the same as those proposed to improve juvenile chinook habitat in the middle Green River. These measures include reconnecting and rehabilitation the Signani Slough side channel, and placement of LWD in the river channel downstream of Tacoma's Headworks. These measures will improve chum salmon rearing habitat in the middle Green River by providing up to 3.4 acres of additional off-channel habitat to chum salmon fry and increasing the number and quality of pools associated by increasing LWD loadings. These mitigation measure will be very beneficial to chum salmon fry, which may require the low-velocity areas provided by off-channel habitat during their late winter and early spring rearing period. Flows in the main channel of the Green River are relatively high during this period, which likely results in poor rearing habitat conditions for chum salmon fry in these areas.

As described for chinook salmon, some benefits will also be realized for several miles of the Green River below HHD by improving (decreasing) water temperatures for salmonids. Temperature modeling results indicated that the natural inflow to HHD exceeds the state Class "AA" temperature standard of 61˚F (16.0˚C) in most years. However, any temperature benefits to chum salmon fry are likely to be insignificant, since most chum fry are only present in the Green River during cooler periods of the year (i.e., late winter through spring).

(2) Watershed Management. Tacoma's forest management activities and conservation measures will not affect chum juvenile rearing in the middle watershed.

c. *Lower Watershed*

(1) Water Withdrawal. As with the middle Green River, flow reductions resulting from the FDWRC and SDWR are predicted to improve mainstem habitat conditions for chum salmon fry in the lower Green River, but will also reduce the availability of side channel habitats. Habitat values were calculated on a daily basis for the chum salmon rearing period to quantify the effects of Tacoma's water withdrawals on chum salmon fry in the lower Green River (the same method used for chinook salmon fry were applied to chum salmon). The results of this analysis indicate that Tacoma's water withdrawals will increase mainstem habitat for chum salmon fry by 19 percent on average. Improvements to chum fry condition in the mainstem river due to the water withdrawals occur because flows in the Green River during the rearing period are usually considerably higher than the range of flows considered to be optimal for chum fry.

Since there is little off-channel habitat in the lower Green River due to extensive channelization for flood control, impacts of the municipal water withdrawals on off-channel habitat conditions for chum salmon will be small.

As described for chinook salmon, water quality problems within the lower Green River include water temperature, DO, nutrient enrichment, and a variety of pollutants. However, the effects of HHD and Tacoma's water withdrawal activities will not extend sufficiently far downstream to significantly affect water quality conditions (particularly temperature) in the lower Green and Duwamish rivers.

Habitat for juvenile chum salmon is generally poor in the lower Green River as a result of channelization for flood control, especially because most side channels in this section of the river have been eliminated. Most chum salmon in the lower Green River rear in the estuary areas of the Duwamish River, or migrate into the shallows of Elliott Bay. For this reason, mitigation measures for juvenile chum salmon, like chinook salmon, focus on habitat enhancement of the upper and middle Green River.

(2) Watershed Management. Tacoma's watershed management activities and conservation measures will not affect chum juvenile rearing in the lower watershed.

17. <u>Pink Salmon - Upstream Migration</u>

a. *Middle and Lower River*

(1) Water Withdrawal. Pink salmon spawn from August through November, which coincides with the chinook salmon migration period. Pink salmon can pass through shallower water than fall chinook salmon because of their smaller size. Because water depths in the lower river are sufficient for upstream passage of chinook salmon when flows at the Auburn gage exceed 200 cfs, Tacoma's water withdrawals are not expected to impede the upstream passage of pink salmon in the lower Green River.

The MIT/TPU Agreement requires minimum flows of at least 250 cfs at the Auburn gage from 15 July to 15 September during all but drought years, when minimum flows may be reduced to 225 cfs. Tacoma will not use the SDWR if instream flows at Palmer fall below 300 cfs during the remainder of the year. These minimum instream flow requirements provide adequate water depths for the upstream passage of pink salmon. Some delay to anadromous forms may occur during sustained low flow periods early in the migration period due to poor water quality conditions and lack of migration cues in the lower river.

Upstream passage of adult fish will be provided by a permanent fish collection and transport facility at the Headworks. However, pink salmon, like chum salmon, are not expected to be introduced into the upper Green River watershed because they are not likely to migrate upstream as far as the Headworks diversion (RM 61.5). Pink salmon generally spawn in the lower reaches of streams and rivers, and have difficulty migrating upstream through large rapids and over waterfalls (Heard 1991). For this reason, pink salmon spawning should be limited to the lower and middle Green River downstream of the Green River Gorge.

(2) Watershed Management. Because pink salmon are not expected to be introduced into the upper watershed, Tacoma's forest management activities and associated conservation measures will not affect pink salmon upstream migration.

18. <u>Pink Salmon - Downstream Migration</u>

a. *Middle and Lower River*

(1) Water Withdrawal. During the spring, pink salmon fry outmigrate to the ocean. Like chum salmon, pink salmon have an "ocean-type" life cycle, and migrate downstream shortly after emerging from gravels. The outmigration period of pink salmon fry in the Green River is probably similar to that of chum salmon (early March through late May). Impacts of the withdrawals are expected to be similar to those of chum salmon fry, a 5.0 percent reduction in survival condition compared to that occurring without the withdrawals.

As described earlier, Tacoma will install a downstream fish bypass facility at the Headworks that will significantly improve the survival of outmigrating juvenile coho salmon, chinook salmon, and steelhead. However, the benefits provided by this facility will not apply to pink salmon because this species is unlikely to spawn in the upper watershed.
The AWS project flow measures are predicted to result in an average reduction in yearly survival condition of chum fry outmigrants of 0.3 percent. The impact of these measures on the downstream survival of pink salmon fry should be similar, because pink outmigrate at the same time and same size as chum salmon. Flows in the Green River are relatively high during April and May, which limits the effects of the reservoir refill on downstream flow fluctuations.

(2) Watershed Management. Because pink salmon are not expected to be introduced into the upper watershed, Tacoma's forest management activities and associated conservation measures will not affect pink salmon downstream migration.

19. <u>Pink Salmon - Spawning and Incubation</u>

a. *Middle and Lower River*

(1) Water Withdrawal. Pink salmon are unlikely to spawn in the upper Green River watershed, since very few fish are expected to migrate upstream as far as the proposed trap-and-haul facility at Headworks. Mainstem spawning habitat of pink salmon in the middle and lower reaches should be impacted by Tacoma's withdrawals to a lesser extent than chinook because pink salmon spawn in shallower areas and at lower velocities than chinook salmon. Chinook salmon spawning habitat in the main channel of the middle Green River was predicted to be reduced by an average of 11.1 percent in the middle Green River by the FDWRC and SDWR withdrawals, and by an average of 15.5 percent in the lower Green River watershed by these withdrawals. The redds constructed by pink salmon are potentially more vulnerable to dewatering than those of chinook salmon because pink salmon spawn in shallower water than do chinook. The effect of Tacoma's water withdrawals on pink salmon were calculated using the same method as for chinook salmon, except that a 0.5-feet minimum spawning depth was applied to pink salmon. Based upon this analysis, the average spawnable width of the main river channel during the pink salmon spawning period was predicted to be 138.1 feet without Tacoma's water withdrawals and 136.9 feet with the water withdrawals. For days when dewatering was predicted to occur, the dewatered spawnable width of the channel averaged 4.1 feet without Tacoma's water withdrawals and 4.4 feet with the water withdrawals. Thus, the water withdrawals were predicted to result in an average increase of 0.3 feet in the dewatered width of the channel for those days when dewatering was predicted to occur during the pink salmon spawning and incubation period. This represents a very small portion of the total width of the channel (i.e., 0.22 percent) within which pink salmon can potentially spawn.

Because pink salmon spawn during the same period of the year as chinook salmon, the impacts of Tacoma's withdrawals on spawning and incubation habitat area in the side channels of the middle Green River should be similar to those for chinook salmon. Tacoma's withdrawals were predicted to reduce the wetted area of side channels in the middle Green River during the pink salmon spawning period by an average of 1.5 acres, which represents a 16 percent reduction during the 1964-1995 period. Effects of the water withdrawals on pink salmon incubation were quantified by comparing continuously wetted side channel habitat for the lowest two-day flow event during the pink salmon incubation period. Tacoma's water withdrawals were predicted to potentially reduce side channel area during the incubation period of pink salmon by 1.5 acres, which represents a 16 percent reduction in the amount of area occurring without the withdrawals.

The gravel nourishment conservation measure will benefit spawning habitat conditions in the middle Green River by augmenting gravel recruitment lost from the upper watershed due to HHD. The target base flows and freshets proposed as part of the AWS project will have minimal benefit to pink spawning and incubation, since these flow augmentation measures primarily affect flows in the Green River only after pink salmon and incubation is complete. Reconnection and rehabilitation of Signani Slough side channel (RM 59.6) and addition of LWD below the Headworks will not benefit pink salmon spawning. Pink salmon are not expected to migrate upstream to the vicinity of the Headworks.

(2) Watershed Management. Because pink salmon are not expected to be introduced into the upper watershed, Tacoma's forest management activities and conservation measures will not affect pink salmon spawning and incubation.

20. <u>Pink Salmon - Juvenile Rearing</u>

a. *Middle and Lower River*

(1) Water Withdrawal. Tacoma's water withdrawals will only affect pink salmon juvenile habitat in the lower and middle Green River, since pink salmon are not expected to be introduced into the upper watershed as a result of the proposed trap-and-haul program at Headworks. Tacoma's water withdrawals potentially affect pink salmon habitat in the middle Green River by reducing flows by up to 213 cfs on a daily basis. These withdrawals will have a similar effect on pink salmon as on chum salmon because both species have an ocean-type life cycle (i.e., juveniles reside in the river for days to weeks prior to migrating to the ocean). Pink salmon fry are likely present in the Green River from early March through June, the same as chum salmon. The analysis of mainstem rearing habitat for chum salmon predicted that Tacoma's withdrawals potentially result in an average 11.4 percent increase in chum fry habitat in the middle Green River and an average 19.0 percent increase in the lower Green River (see Chapter 7.5.4.3). The same values are assumed to be applicable to pink salmon fry.

The effects of Tacoma's water withdrawals on pink salmon rearing habitat in the side channels of the middle Green River were quantified using the same wetted side channel area versus discharge relationships applied to chum salmon fry. The results of the habitat modeling predict an average 1.4-acre reduction (18.4 percent loss) in the total wetted area of side channels in the middle Green River resulting from Tacoma's water withdrawals during the pink salmon fry rearing period. There is little side channel habitat in the lower Green River due to extensive channelization for flood control, thus impacts of the municipal water withdrawals on off-channel habitat conditions for pink salmon are expected to be small.

Many of the habitat conservation measures intended to improve pink salmon fry rearing habitat are the same as those proposed to improve juvenile chum habitat in the middle Green River. These measures include the release of freshets and placement of LWD in the river channel. Large woody debris transported to the middle of the Green River will create localized low-velocity areas conducive to pink salmon rearing. As for chum salmon, this mitigation measure will be beneficial to pink salmon fry, which require low-velocity areas such as those provided by the side channels during their rearing period.

Habitat for pink salmon rearing is generally poor in the lower Green River as a result of channelization for flood control, especially because most side channels in this section of the river have been eliminated. For this reason, the proposed mitigation projects will be targeted to improving salmonid rearing habitat conditions in the middle section of the Green River, and will not affect pink salmon rearing habitat in the lower watershed.

(2) Watershed Management. Because pink salmon are not expected to be introduced into the upper watershed, Tacoma's forest management activities and conservation measures will not affect pink salmon juvenile rearing.

21. Steelhead - Upstream Migration

a. *Upper Watershed*

(1) Water Withdrawal. As for other anadromous fish species, the Headworks diversion structure prevents the upstream migration of adult steelhead above RM 61.0. Additionally, HHD at RM 64.5 represents a second barrier to the upstream migration of anadromous fish into the upper Green River watershed since its construction in the early 1960s. Like coho salmon, steelhead are mainstem and tributary spawners. However, steelhead can spawn in higher gradient tributaries than coho salmon, so there is more habitat in the upper watershed within which steelhead can potentially spawn. There are approximately 66 miles of mainstem and tributary habitat in the upper Green River watershed (above HHD) that are suitable for steelhead spawning (i.e., total mileage for all stream and mainstem sections of 5 percent or less gradient) (USACE 1998, Appendix F1).

Tacoma has been trapping adult steelhead at Headworks since 1992 using a temporary trap-and-haul facility. Between 70 and 130 steelhead have been trapped each year to date, with native adults released into the upper watershed. In addition, native winter stock steelhead fry have been outplanted into tributaries of the upper Green River since 1982 by the WDFW. The number of steelhead fry outplanted into the upper watershed has ranged from approximately 30,000 to 55,000 fish per year.

Native adult steelhead will continue to be reintroduced into the upper Green River watershed above HHD following the installation of a permanent fish collection and transport facility at the Headworks. Steelhead will be reintroduced into the upper Green River watershed using the same methods applied to chinook and coho salmon. Restoring anadromous fish access to the upper watershed significantly increases the availability of suitable habitat to steelhead in the Green River basin. Comparing the upper watershed adult steelhead escapement goal, estimated by the USACE (1998, Appendix F1), to the Tribal and state escapement goals for the middle and lower Green River and Newaukum Creek (WDFW et al. 1994) suggests that 66 miles of habitat in the upper watershed represents about 40 percent of the winter steelhead habitat potentially available in the Green/Duwamish basin.

(2) Watershed Management. Implementation of upland forest and riparian conservation measures will have a positive effect on steelhead upstream migration in the Upper HCP Area. Mass-wasting prescriptions developed through watershed analysis are expected to reduce management-related contributions of coarse sediment. Over the long-term, this could reduce the extent of aggraded reaches that consistently experience subsurface flows during dry summers. Reestablishment of riparian forests dominated by coniferous trees greater than 50 years old will increase shade, moderating elevated summer temperatures caused by lack of adequate shade. Increasing the proportion of riparian stands greater than 50 years of age from 27 to 100 percent will result in a gradual increase in the recruitment of LWD. In addition, the increased abundance of late-seral stands is expected to ensure that at least some of the LWD that enters the stream system is large enough to function as key pieces, which are especially important for forming deep pools in larger channels. Tacoma's ownership encompasses most of the mainstem and large tributary habitat preferred as holding habitat by large bodied salmonids such as steelhead, thus temperature reductions and increased LWD inputs resulting from development of mature coniferous riparian forests on Tacoma's lands are expected to be especially beneficial for upstream migrating steelhead.

Stream crossing culverts on Tacoma's land will be inventoried, and repaired or replaced as required within 5 years of issuance of the ITP. Stream crossings will be maintained in passable condition for the duration of the ITP. This measure will increase the amount of habitat that is accessible to upstream migrating steelhead, although the magnitude of that increase cannot be estimated until the inventory is complete.

b. *Middle Watershed*

(1) Water Withdrawal. Tacoma's water withdrawals will likely have little effect on the upstream migration of adult native winter steelhead. Unlike chinook and coho salmon, which migrate up the Green River during the late summer and fall, native winter steelhead do not

commence their upstream migration until the winter months (i.e., January). The upstream migration period of native winter steelhead coincides with the period of high seasonal flows in the Green River. Because water depths in the lower river were determined to be sufficient for upstream passage of chinook salmon when flows at the Auburn gage exceed 200 cfs, Tacoma's water withdrawals should have no impact on the upstream passage of native steelhead in the middle Green River since flows are substantially higher than 200 cfs throughout the steelhead migration period.
During the native steelhead winter and spring migration period, water temperatures in the middle Green River are cool and DO concentrations high. Consequently, the upstream migration of adult native steelhead should not be impeded by water quality conditions in the middle river. Since water withdrawal will not affect flow or water quality during the steelhead upstream migration period, no conservation measures are necessary to improve the upstream migration of adult steelhead.

(2) Watershed Management. Tacoma's forest management activities and associated conservation measures will not affect steelhead upstream migration in the middle watershed.

c. *Lower Watershed*

As in the case of the middle Green River, Tacoma's water withdrawals and forest management activities are expected to have no effect on the upstream migration of native steelhead in the lower watershed.

22. Steelhead - Downstream Migration

a. *Upper Watershed*

(1) Water Withdrawal. Tacoma's water withdrawals will primarily affect the downstream passage of juvenile steelhead in the Green River below the Headworks diversion facility (including the diversion dam and pool). Consequently, Tacoma's water supply diversions will have little direct impact on downstream migration in the upper watershed. Effects of water storage are addressed as a USACE activity under Section 7 of the ESA.

Since active pumping of the North Fork well field will reduce surface flow in the North Fork of the Green River above HHD, groundwater withdrawals could affect the downstream migration of juvenile steelhead. The North Fork well field is used during periods of high turbidity in the mainstem Green River, which typically occur during the winter, coincident with high surface flows in the North Fork. Use of the well field is assumed to have minimal effects on outmigrating steelhead smolts, since they outmigrate during April through June.

While the USACE is responsible for the effects of water storage and release at HHD, Tacoma will be the local sponsor of the downstream fish passage facility to be installed at HHD. The operation of this facility is important to maintain high levels of steelhead smolt survival through Howard Hanson Reservoir and Dam following the re-introduction of adult spawners into the upper Green River. The estimated survival rate of steelhead smolts for combined reservoir and dam passage resulting under operation of the HHD fish passage facility is 90 percent, compared to a survival rate of 8.7 percent under pre-AWS project conditions (USACE 1998, Appendix F1, Section 8E).

(2) Watershed Management. Extensive harvest of forest stands at elevations that commonly develop a snowpack but also frequently experience heavy, warm winter rains may increase the magnitude of peak flows (WFPB 1997). However, in the Pacific Northwest, the majority of such events occur during late November and February, prior to the period when juvenile salmonids begin to move downstream. Since watershed management prescriptions contain provisions to restrict the potential for increased peak flows to less than 10 percent, and forestry activities are not expected to influence flows during the salmonid outmigration season (April through June in the Green River basin), neither Tacoma's forest management activities or conservation measures will affect steelhead downstream migration.

b. *Middle and Lower Watershed*

(1) Water Withdrawal. Tacoma's water withdrawals could have two impacts on the survival of outmigrating juvenile steelhead. First, some of the smolts outmigrating through the Headworks diversion pool could be impinged on the existing screens or entrained into the water intake at the diversion. Fish impinged on the screens or entrained into the water supply system are assumed to ultimately perish. The survival of outmigrating steelhead smolts passing through the Headworks reach should be higher than that of juvenile coho salmon even though both species outmigrate during the same time of the year (early April through June). Steelhead typically reside in fresh water for two to three years prior to smolting and are typically larger than coho smolts, which have a shorter freshwater residency. The larger size of steelhead smolts makes them less vulnerable to entrainment and impingement. Existing screens at the Headworks do not meet current NMFS design criteria; however, data on existing outmigrant entrainment and survival at Tacoma's Headworks are not available.

Second, the survival of outmigrating steelhead smolts in the middle and lower Green River channel below the Headworks is probably influenced by flow, as with chinook salmon. Tacoma's FDWRC and SDWR withdrawals are expected to result in decreased outmigrant survival values of steelhead by reducing flows in the Green River below Headworks. In order to assess the impact of Tacoma's water withdrawals on the survival of outmigrating steelhead smolts, daily estimates of survival condition were calculated for proposed Green River flows under the HCP (Green River flows with the AWS project and with Tacoma withdrawals) and compared to Green River flows without the AWS project and without Tacoma withdrawals. Steelhead smolt survival condition was calculated for each of these flow conditions using the same method used for chinook salmon. These daily survival rates were calculated for the steelhead salmon outmigration period (1 April through 30 June), and were weighted according to the estimated percentage of smolts outmigrating down the river on a daily basis (based upon the outmigration periodicity distribution developed by Grette and Salo, 1986).

The analysis of flow changes on outmigrant survival condition was based on experiments conducted by University of Washington researchers (Wetherall 1971). Their experiments were conducted using hatchery-reared chinook juveniles that averaged 3.1 inches (80 mm) in length. Steelhead juveniles outmigrate after spending one to three years rearing in the stream environment and are often 6 inches (150 mm) or more in length. Many researchers believe that larger outmigrants exhibit increased survival relative to smaller outmigrating salmonids during outmigration, possibly due to faster swimming speeds (Chapman et al. 1994) or lower susceptibility to predation by sculpin. The actual effects of Tacoma's water withdrawals on steelhead outmigrant survival are expected to be less than the average 4.9 percent reduction in survival condition obtained through modeling. Steelhead smolt survival is expected to be less influenced by flow changes than the small chinook smolts due to the larger size and vigorous nature of the steelhead.

The results of this analysis indicate that the flow reductions in the Green River channel caused by exercise of the FDWRC and SDWR result in an average reduction in steelhead smolt outmigrant survival condition of 4.9 percent. Potential reductions in yearly outmigrant survival values ranged from 1.2 to 7.2 percent for the 1964-1995 period.

As described earlier, Tacoma will install a downstream fish bypass facility at the Headworks at RM 61.0 that includes a 220-ft- by 24-ft conventional screen. This conservation measure will improve the survival of outmigrating steelhead smolts passing Tacoma's Headworks by preventing fish from being impinged or entrained into the water supply intake. Upgrading the existing Headworks screens to meet NMFS design criteria is assumed to improve steelhead smolt survival.

Flow augmentation in May and June resulting from implementation of the AWS project will also improve the survival of outmigrating steelhead smolts in the Green River. Because the period of spring flow augmentation under the AWS project occurs during the peak outmigration period of steelhead (i.e., 1 May through 31 May), this measure is expected to improve smolt outmigrant survival. The benefits to steelhead migrants provided by AWS project spring flow augmentation measures were calculated using the same method used for juvenile chinook salmon. The average predicted improvement in steelhead smolt survival condition resulting from the AWS project is 3.3 percent. Estimated increases in yearly survival values resulting from the implementation of flow augmentation range from 0.5 percent to 5.7 percent for the 1964-1995 period.

(2) Watershed Management. Tacoma's watershed management activities and conservation measures will not affect steelhead downstream migration in the middle and lower watershed.

23. <u>Steelhead - Spawning and Incubation</u>

a. *Upper Watershed*

(1) Water Withdrawal. Tacoma's water withdrawals at the Headworks will not affect spawning habitat and incubation of steelhead in the upper Green River basin above HHD. Pumping of groundwater from the North Fork well field could have a minor effect on steelhead spawning and incubation in the North Fork of the Green River. However, pumping is unlikely to significantly reduce surface flows during the spring high flow period when steelhead spawn.

As described earlier, Tacoma has trapped and hauled native adult steelhead from the Headworks diversion into the upper Green River watershed since 1992 using a temporary capture facility. Between 70 and 133 native adult steelhead have been captured at this facility, and have either been reintroduced into the upper watershed or used as brood stock for the fry outplanting program. The proposed permanent trap-and-haul facility at Headworks will have the capability of substantially increasing the number of native steelhead spawners introduced into the upper watershed.

Steelhead are expected to spawn in low and moderate gradient reaches (5 percent or less) in mainstem and tributary within the upper watershed (USACE 1998, Appendix F1, Section 2). The USACE estimated there are 66 miles of mainstem and tributary spawning habitat in the upper Green River watershed that are accessible to upstream migrant steelhead and that have channel gradients of 5 percent and less (USACE 1998, Appendix F1, Section 2).

(2) Watershed Management. The potential effects of Tacoma's forest management activities on spawning and incubation in the upper watershed are similar to those described for chinook in Chapter 7. Implementation of watershed management conservation measures will have a positive effect on salmonid spawning and incubation in the Upper HCP Area. Implementation of mass-wasting prescriptions and the RSRP developed through watershed analysis is expected to reduce management-related contributions of fine sediment to less than 50 percent over background. This may result in a decrease in the proportion of fine sediment contained by spawning gravels, and could result in increased survival to emergence.

Reestablishment of riparian forests dominated by coniferous trees greater than 50 years old will result in a gradual increase in the recruitment of LWD. In addition, the increased abundance of late-seral stands is expected to ensure that at least some of the LWD that enters the stream system is large enough to function as key pieces, which are especially important for forming stable flow obstructions in larger channels. The net result should be an increase in in-channel LWD and an associated increase in the availability of spawning gravel, especially in moderate gradient (2-5 percent) tributary streams preferred by steelhead. Steelhead will benefit from increased spawning gravel availability in both mainstem and moderate to high gradient tributaries.

b. *Middle Watershed*

(1) Water Withdrawal. Tacoma's water withdrawals will influence the availability of steelhead spawning habitat in both the mainstem river and side channel areas of the middle Green River.

Reduced flows caused by these withdrawals may also increase the susceptibility of steelhead redds to dewatering by exposing mainstem and side channel areas during the incubation period. Compared to salmon, steelhead are more likely to spawn in the mainstem sections of the river rather than in the side channel sections. The effects of Tacoma's withdrawals on mainstem steelhead spawning habitat in the middle Green River were quantified using the same method applied to chinook salmon (i.e., based upon Ecology's Green River IFIM study). The daily potential habitat values occurring during the spawning period of steelhead under Green River flows with Tacoma withdrawals and Green River flows without Tacoma withdrawals were calculated using potential habitat and flow functions developed for the Green River for this species by Ecology (Caldwell and Hirschey 1989). Based upon this analysis, steelhead spawning habitat in the main channel of the middle Green River will be improved by an average of 8.7 percent by exercise of the FDWRC and SDWR water withdrawals. The only decrease in spawning habitat caused by the withdrawals (-4.2 percent) was predicted during 1992, a dry year. In contrast, the diversions resulted in a 12.8 percent increase in potential spawning habitat area during 1993. The Ecology instream flow study predicted that flow between 550 and 650 cfs provides optimal spawning habitat for steelhead in the middle Green River. Because flows in the Green River typically exceed this optimal range of flows throughout the spawning period of steelhead (early April to late June), Tacoma's withdrawals are predicted to result in an overall improvement in spawning conditions for this species in the mainstem middle Green River. The effects of Tacoma's water withdrawals on steelhead spawning habitat area in the side channels of the middle Green River were quantified using wetted side channel area versus discharge relationships. The same method used for estimating chinook salmon spawning habitat area in the side channels was applied to steelhead. Values of side channel habitat were calculated on a daily basis for the steelhead spawning period (1 April through 30 June). The results of these analysis indicate that Tacoma's withdrawals will reduce the wetted area of side channels in the middle Green River by an average of 12.6 percent during the steelhead spawning period. This represents a 1.9-acre reduction in the average wetted area provided by side channels in the middle Green River during this period.

The impacts of Tacoma's FDWRC and SDWR withdrawals on steelhead incubation were assessed by calculating the width of the channel subject to redd dewatering (i.e., dewatered spawnable width) using the same method applied to chinook salmon. Spawnable and dewatered channel widths were calculated on a daily basis for the steelhead spawning period. Dewatered spawnable widths were calculated from transect and rating curve data obtained from Nealy Bridge Transect 6 (Ecology instream flow study), and were determined assuming a 50-day incubation period (i.e., time from redd deposition to fry emergence). These widths were weighted according to the percentage of steelhead redds present in the mainstem Green River on a daily basis throughout the March through June spawning period (see Table A1, Appendix A). The Nealy Bridge Transect 6 was selected by Caldwell (1992) for the purpose of analyzing the effects of river stage reductions on steelhead spawning habitat. Although steelhead spawning was observed to be heavy in the vicinity of this transect, the width of this transect is less sensitive to changes in flow that some of the transects established at other sites during Ecology's Green River instream flow study. Consequently, the width calculations obtained for this transect may underestimate the impacts of the water withdrawals if extrapolated to the entire river.

The assumption that embryonic development from fertilization to emergence lasts 50-days is a modeling simplification. The time required for egg incubation and alevin development to the emergent fry stage is dependent upon the accumulation of Fahrenheit Temperature Units (FTUs), which in turn is a function of water temperature. Seattle Water Department researchers found that winter steelhead fry emerge from the gravel in the Cedar River after accumulating between 1045 and 1284 mean FTUs, with mean emergence at about 1165 FTUs. Green River water temperatures during the incubation period range from about 45˚F in early March to about 62˚F in mid-August. In the Green River, the number of days required to accumulate 1165 FTUs from march through June varies between from 40 to 45 days for eggs fertilized near the end of June to from 75 to 80 days for eggs fertilized in early March. For this analysis, 50 days was selected as the time between fertilization to emergence for modeling purposes. Based on the 50-day assumption, the steelhead spawning and incubation model developed for this analysis projected that fry would emerge from the gravel between 20 April (early March spawn) and 19 August (late June spawn). In reality, fifty days underestimates development time for eggs fertilized in March through the first two weeks in May, and overestimates development time for eggs fertilized during the last two weeks in June. Fifty days is a good estimate for eggs fertilized during the last two weeks in May through the first two weeks in June.

The average weighted spawnable width of the main river channel during the steelhead spawning period was predicted to be 145.4 feet without Tacoma's water withdrawals and 144.4 feet with the water withdrawals. For days when redd dewatering was predicted to occur, the dewatered spawnable width of the channel averaged 1.5 feet without Tacoma's water withdrawals and 1.9 feet with the water withdrawals. Thus, the water withdrawals are predicted to result in an average increase of 0.4 feet in the dewatered width of the channel for days when redd dewatering is predicted to occur. This represents a very small portion of the total width of the channel (i.e., 0.03 percent) within which steelhead can potentially spawn. The protected spawnable width of the channel (i.e., the spawnable width not subject to dewatering calculated by subtracting dewatered width from spawnable width) was 143.9 feet without the withdrawals and 142.5 feet with the withdrawals. The withdrawals therefore reduce the protected spawnable width of the channel by 1.4 feet. The water withdrawals were found to increase the frequency of dewatering by an average of one day during the 120-day steelhead spawning period. Dewatering of some portion of the spawnable width of the channel is predicted to occur for an average of 28 days with the withdrawals and 27 days without the withdrawals. Steelhead redds were historically probably dewatered in some years even without Tacoma's diversions. The modeled natural flow data indicate that the average 7-day low flow between 1 April and 30 May for the period of 1964 to 1995 was 982 cfs. However, modeled natural 7-day lows flows as low as 270 cfs occurred during April and May, and were less than 550 cfs in five of the 32 years of record. The results of this analysis indicate that Tacoma's water diversions will have a minor impact on the survival of steelhead eggs and embryos in mainstem sections of the middle Green River.

The impacts of Tacoma's water withdrawals on steelhead incubation habitat in the side channels of the middle Green River were assessed using the side channel habitat area versus discharge curves developed by the USACE (1998). Effects of the diversions on steelhead incubation habitat were quantified using the same method applied to chinook salmon. The results of this analysis indicated that Tacoma's withdrawals will reduce the area of side channels in the middle Green River during two-day low flow events (i.e., the flow event most likely to dewater redds) by an average of 1.4 acres (i.e., 23.0 percent reduction) from that occurring without the withdrawals during the steelhead incubation period (1 May through 31 July).

The gravel nourishment conservation measure will benefit steelhead spawning habitat in the middle Green River by augmenting the gravel recruitment lost from the upper watershed due to HHD. Reconnection and restoration of side channels will also improve spawning habitat conditions by providing up to 3.4 acres of additional side channel habitat in the middle Green River. This measure will provide up to a 25 percent increase in the total area of side channel habitat potentially available to spawning steelhead (based upon the average side channel area occurring without the HCP mitigation measures during the steelhead spawning period).
The early reservoir refill, spring flow augmentation, and freshets proposed as part of the AWS project will affect the spawning conditions for steelhead, because the spawning period of this species (1 March to 30 June) coincides with the early refill and flow augmentation period. (Note: These flow measures have been targeted to mainstem steelhead production by providing higher sustained baseflows during their incubation period.) The early refill, flow augmentation, and freshet measures will increase the average weighted spawnable width of the mainstem river channel from 144.0 feet (without AWS project) to 144.4 feet. The AWS project flow measures will result in an overall improvement in steelhead incubation by reducing the frequency of low flow events during the late spring, which are most likely to dewater redds. The AWS project flow measures include two 36-hour freshets, which slightly increase the average value of dewatered spawnable width (1.9 feet) from that occurring without the flow measures (1.5 feet). Thus, these freshets increase the average dewatered width for days when dewatering occurs by 0.4 feet. However, this value may not represent an actual impact to steelhead since the freshets are probably too short in duration (36 hours) for a steelhead to construct a redd and complete spawning.

(2) Watershed Management. Tacoma's forest management activities and associated conservation measures will not affect steelhead spawning and incubation in the middle watershed.

c. *Lower Watershed*

(1) Water Withdrawal. Spawning habitat for steelhead, like that for the salmon species, is relatively poor in the lower Green River watershed compared to that in the middle watershed due to extensive channelization. Potential steelhead spawning habitat versus discharge relationships obtained for lower Green River from Ecology's instream flow study (Caldwell and Hirschey 1989) were used to quantify the impacts of the FDWRC and SDWR water withdrawals on the spawning habitat of this species in the lower Green River. Tacoma's water withdrawals are predicted to increase potential steelhead spawning habitat in the lower Green River by an average of 8.9 percent for the March through June spawning period. This estimate applies to main channel habitat only, since there are few side channels of significant size in the lower Green River. Impacts to steelhead incubation in the lower river are expected to be less than those in the middle river (i.e., 0.4 foot increase in average dewatered width for days in which dewatering occurs), since the lower river is substantially narrower due to channelization.

The opportunities for improving spawning habitat in the lower Green River are very limited due to the disturbed condition of the river channel, which has been extensively modified for flood control purposes. For this reason, those conservation measures that will result in improvements in steelhead spawning habitat and incubation (e.g., gravel seeding) focus mainly on the middle section of the Green River, and will not affect habitat in the lower watershed.

The early reservoir refill, spring flow augmentation, and freshets proposed as part of the AWS project flow measures will have the same overall beneficial effect on steelhead spawning and incubation in the lower Green River as they do in the middle river although these benefits will be diminished due to the channelized nature of the lower river.

(2) Watershed Management. Tacoma's forest management activities and associated conservation measures will not affect steelhead spawning and incubation in the lower watershed.

24. Steelhead - Juvenile Rearing

a. *Upper Watershed*

(1) Water Withdrawal. Tacoma's water withdrawals will primarily affect juvenile steelhead habitat in the lower and middle Green River (i.e., below Headworks). Pumping of groundwater from the North Fork well field is expected to have a minor effect on steelhead rearing in the North Fork Green River since well field pumping primarily occurs during high flow periods during the late fall, winter and early spring (these high flow periods are largely responsible for the elevated turbidity levels that necessitate the use of the groundwater pumping facility). Pumping during the summer and early fall, though rare, is expected to have a negative effect on steelhead rearing habitat in the North Fork once this species is reintroduced into the upper watershed. Most juvenile steelhead rear in the upper watershed for at least two years, and would be expected to reside in the North Fork throughout the entire year.

The trap-and-haul facility to be built by Tacoma will allow more of the adult steelhead (native winter run) that reach the Headworks diversion structure to be captured and then released into the upper watershed above HHD. In addition to reconnecting the upper watershed to the lower watershed using the trap-and-haul and downstream fish passage facilities, habitat habilitation projects will also be implemented by Tacoma and the USACE in the upper watershed during Phase I of the AWS project. The rehabilitation projects to be implemented as part of the AWS project restoration and mitigation activities will provide increased rearing and overwintering habitat for anadromous and resident salmonids, including juvenile steelhead. These projects include constructing an additional 3.9 acres of off-channel habitat, which will provide important overwintering habitat for juvenile steelhead in the upper watershed. Large woody debris will be introduced into the new off-channel areas and approximately 18 miles of mainstem and tributary habitat, increasing channel complexity and the number of pools associated with wood, thereby increasing the quantity and quality of rearing habitat available to juvenile steelhead.

(2) Watershed Management. The potential effects of Tacoma's forest management activities on steelhead juvenile rearing habitat are similar to those described for chinook in Chapter 7.1.4. Implementation of watershed management conservation measures will have a positive effect on juvenile rearing in the Upper HCP Area. Mass-wasting prescriptions are expected to reduce the frequency of landslides that deliver sediment and initiate dam break floods. Management-related contributions of fine sediment to less than 50 percent over background under the RSRP. These measures are expected to result in a decrease in embeddedness, which will be especially beneficial to species such as steelhead that overwinter in interstitial spaces.

Reestablishment of riparian forests dominated by coniferous trees greater than 50 years old will result in a gradual increase in the recruitment of LWD. As in-channel LWD increases, the frequency of pools is also expected to increase. Pool cover will improve as a result of the additional LWD. The net result should be an increase in the quality and quantity of pool habitat used for juvenile steelhead summer and winter rearing. As riparian stands mature, the number of large conifers capable of acting as barrier tress during dam-break floods will increase. The increased abundance of barrier trees, combined with the decreased frequency of mass wasting is expected to reduce the risk of dam-break floods that can kill or injure juvenile steelhead overwintering in the substrate.

Stream crossing culverts on Tacoma's lands will be inventoried and repaired or replaced as required within 5 years of issuance of the ITP. Stream crossings will be maintained in passable condition for the duration of the ITP. This measure will increase the amount of tributary and off-channel habitat that is accessible to steelhead for use as off-channel rearing habitat, although steelhead are less likely to utilize such habitat than salmon. The magnitude of that increase cannot be estimated until the inventory is complete.

b. *Middle Watershed*

(1) Water Withdrawal. Tacoma's water withdrawals will affect steelhead rearing habitat by reducing flows in the Green River below the Headworks up to 213 cfs on a daily basis. The withdrawals potentially have a greater effect on steelhead than chinook salmon and coho salmon since most steelhead juveniles reside in the Green River basin for a least two years prior to migrating to the ocean. Tacoma's FDWRC and SDWR withdrawals will affect steelhead rearing in the main river channel as well as in the side channels present along the middle Green River. The side channel habitat areas may be less important to juvenile steelhead than juvenile coho, chinook, and chum salmon, since juvenile steelhead are widely distributed throughout the pools, runs, and riffles of the mainstem Green River.

The effects of Tacoma's withdrawals were quantified using IFIM habitat area and flow functions developed for juvenile steelhead in the middle Green River by Ecology. Daily habitat values occurring under proposed HCP conditions (Green River flows with the AWS project and with Tacoma withdrawals) were compared to those occurring under Green River flows without the AWS project and without Tacoma withdrawals. The analysis indicates that Tacoma's withdrawals (both FDWRC and SDWR) will result in an average 7.9 percent increase in juvenile steelhead habitat in the mainstem middle Green River during their year-round rearing period. Flows in the middle Green River are typically higher than those considered to be optimal for juvenile steelhead (350 to 400 cfs) by Ecology's instream flow study (Caldwell and Hirschey 1989), except during low flow periods in the late summer and early fall. During these low flow periods, juvenile steelhead habitat values are sustained at relatively high levels (i.e., > 90 percent of optimal) by the minimum flow measures that have been established by the MIT/TPU Agreement.

A comparison of the proposed HCP flow regime to flow conditions in the absence of Tacoma withdrawals and HHD (natural) indicates that average monthly flows are somewhat lower during the primary steelhead juvenile growth season (June through September). The HCP flow regime provides flows closer to the maximum habitat condition indicated by Ecology's instream flow study in June and July but slightly lower habitat values in August and September. Lower average habitat conditions in August and September are somewhat offset by flow augmentation that prevents extreme 7-day low flows from dropping to historic levels.

Selected hydrologic characteristics of flows (cfs) in the Green River under the modeled Natural and HCP flow regimes for the period 1964 to 1995 (Source: CH2M Hill 1997).

Average Monthly Flow (cfs)	Natural	HCP
June	1208	1024
July	586	466
August	364	335
September	401	371
Low Flow 15 July to 15 September		
Average 7-day Low Flow	290	294
Minimum 7-day Low Flow	203	250

The effects of Tacoma's water withdrawals on steelhead rearing habitat in the side channels of the middle Green River were quantified using the same wetted side channel area versus discharge relationships employed in the chinook salmon analysis. Changes in availability of side channel area were calculated on a year-round basis, since most juvenile steelhead reside in the Green River for two years. The results of analysis predict an average 12.6 percent loss in total wetted area for the side channels located between RM 61.0 and RM 33.8 (i.e., the majority of side channels in the Green River below HHD) during the year-round rearing period of steelhead. This represents a 1.6-acre average reduction in the total area of side channels in the middle Green River during the year-round steelhead rearing period.

The conservation measures designed to improve juvenile steelhead habitat are the same as those described to improve juvenile chinook habitat in the middle Green River. These measures include reconnecting and restoring the Signani Slough side channel, and placement of LWD in the river channel. These measures will improve steelhead rearing habitat by providing up to 3.4 acres of additional off-channel habitat, which is important for overwintering, and by increasing the structural complexity of main channel habitats.

As described for chinook and coho salmon, some benefits will also be realized for several miles of the Green River below HHD by improving (decreasing) water temperatures for rearing salmonid fish, including steelhead. As described in Chapter 7.1.4.2 of the HCP, the operation of HHD provides temperature benefits to rearing salmonids by significantly reducing water temperatures in sections of the river immediately downstream of the dam during warm periods of the year. However, this benefit diminishes downstream of Palmer due to progressive warming of the river as it approaches equilibrium with air temperatures.

(2) Watershed Management. Tacoma's forest management activities and associated conservation measures will not affect steelhead juvenile rearing in the middle watershed.

c. *Lower Watershed*

(1) Water Withdrawal. As with the middle Green River, flow reductions resulting from exercise of the FDWRC and SDWR will improve mainstem habitat conditions for steelhead in the lower Green River but will reduce the availability of side channel habitats. Municipal water withdrawals modeled using daily flows from 1964-1995 for the lower river result in an average 6.7 percent increase in mainstem habitat for juvenile steelhead during their year-round rearing period. Since there is little off-channel habitat in the lower Green River due to channelization and flood control, impacts of municipal water withdrawals to off-channel habitat will be small. As described for chinook salmon, water quality problems within the lower Green River include water temperature, DO, nutrient enrichment, and a variety of pollutants. However, the effects of HHD and Tacoma's water withdrawal activities will not extend sufficiently far downstream to significantly affect water quality conditions (particularly temperature) in the lower Green and Duwamish rivers. The implementation of freshets during fall low flow conditions, if included as part of the optional storage of 5,000 ac-ft for low flow augmentation, could potentially provide short-term improvements in water quality conditions in the lower Green River to induce and improve upstream passage of adult coho and chinook salmon. However, these freshets will not be sufficient in duration to provide tangible benefits to rearing steelhead.

Juvenile steelhead habitat is generally poor in the mainstem lower Green River as a result of channelization for flood control. For this reason, mitigation measures for juvenile steelhead focus on habitat enhancement of the upper and middle Green River, and will not affect steelhead juvenile rearing habitat in the lower watershed.

B. Determination of Post-relinquishment Mitigation

The terms and processes for determining any additional mitigation owed by Tacoma Water for relinquishment, revocation or suspension of the ITP are described in Section 6.3 of the Implementing Agreement. The primary feature of the post-relinquishment agreement is that mitigation requirements are determined by the Services based on the covered activities that may be requested to be continued, if any, the impact(s) of activities being relinquished, and the type and amount of mitigation that would have been required if Tacoma Water has carried out the full term of the HCP. The Services are reasonably assured that, through this agreement and analyses that would be conducted pursuant to ITP relinquishment, any and all necessary mitigation for impacts of Tacoma's activities will be secured.

C. Cumulative Effects

Cumulative effects include the effects of future state, tribal, local or private actions not involving Federal activities that are reasonably certain to occur within the action area of the Federal action subject to this consultation. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to Section 7 of the Act.

State, Tribal and local government actions will likely be in the form of legislation, administrative rules or policy initiatives. Government and private actions may include changes in land and water uses, including ownership and intensity, any of which could impact listed species or their habitat. Government actions are subject to political, legislative and fiscal uncertainties. These realities, added to geographic scope of the action area which encompasses numerous government entities exercising various authorities and the many private landholdings, make any analysis of cumulative effects difficult and frankly speculative. This section identifies representative actions that, based on currently available information, are reasonably certain to occur. It also identifies some goals, objectives and proposed plans by government entities, however, NMFS is unable to determine at this point in time whether any proposals will in fact result in specific actions.

1. Representative State Actions

Washington State administers the allocation of water resources within its borders. The state could choose to allow further water appropriations. State and local governments are cooperating with each other to increase environmental protections, including better habitat restoration. NMFS also cooperates with the state water resource management agencies in assessing water resource needs in the basin, and in developing flow requirements that will benefit listed fish. During years of low water, however, there could be insufficient flow to meet the needs of the fish. These government efforts could be discontinued or even reduced, so their cumulative effects on listed fish is unpredictable.

The state of Washington has various strategies and programs designed to improve the habitat of listed species and assist in recovery planning, including the Salmon Recovery Planning Act, a framework for developing watershed restoration projects. The state is developing a water quality improvement scheme through the development of TMDLs.

Economic diversification has contributed to population growth and movement in the state, a trend likely to continue for the next few decades. Such population trends will place greater demands in the action area for electricity, water and buildable land; will affect water quality directly and indirectly; and will increase the need for transportation, communication and other infrastructure development. Growth in new businesses is creating urbanization pressures with increased demands for buildable land, electricity, water supplies, waste disposal sites and other infrastructure. The impacts associated with economic and population demands will affect habitat features, such as water quality and quantity, which are important to the survival and recovery of the listed species. The overall effect is likely to be negative, unless carefully planned for and mitigated.

Washington enacted a Growth Management Act to help communities plan for growth and address growth impacts on the natural environment. If the programs continue they may help lessen some of the potential adverse effects identified above.

2. Local Actions

Local governments are faced with similar but more direct pressures from population growth and movement. There are demands for intensified development in rural areas as well as increased demands for water, municipal infrastructure and other resources. The reaction of local governments to such pressures is difficult to assess without certainty in policy and funding. In the past local governments in the action area generally accommodated additional growth in ways that adversely affected fish habitat. Also there is little consistency among local governments in dealing with land use and environmental issues so that any positive effects from local government actions on listed species and their habitat are likely to be scattered throughout the action area.

Some local governments are considering ordinances to address aquatic and fish habitat health impacts from different land uses. Some local government programs, if submitted, may qualify for a limit under the NMFS' ESA section 4(d) rule which is designed to conserve listed species. Local governments also may participate in regional watershed health programs, although political will and funding will determine participation and therefore the effect of such actions on listed species. Overall, without comprehensive and cohesive beneficial programs and the sustained application of such programs, it is likely that local actions will not have measurable positive effects on listed species and their habitat, but may even contribute to further degradation.

3. Tribal Actions

Treaty Indian tribes are co-managers of the fishery resource and promulgate their own harvest regulations and influence the regulations that affect others. Tribal governments are likely to continue to participate in cooperative efforts involving watershed and basin planning designed to improve fish habitat. The previous comments related to growth impacts apply also to Tribal government actions. Tribes have far less land under their direct control than other governments in the basin, and their likelihood of producing effects that positively or negatively affect habitat are substantially less.

4. Private Actions

The effects of private actions are the most uncertain. Private landowners may convert current use of their lands, or they may intensify or diminish current uses. Individual landowners may voluntarily initiate actions to improve environmental conditions, or they may abandon or resist any improvement efforts. Their actions may be compelled by new laws, or may result from growth and economic pressures. Changes in ownership patterns will have unknown impacts. NMFS' observation is that the trends of private actions continue a trajectory of increasing habitat degradation.

5. Summary

Non-federal actions on listed species are likely to continue affecting listed species. The cumulative effects in the action area are difficult to analyze considering the geographic landscape, and the political variation in the action area, the uncertainties associated with government and private actions, and the changing economies of the region. Whether these effects will increase or decrease is a matter of speculation; however, based on the trends identified in this section, the adverse cumulative effects are likely to increase. Although state, tribal, and local governments have developed plans and initiatives to benefit listed fish, they must be applied and sustained in a comprehensive way before NMFS can consider them "reasonably foreseeable" in its analysis of cumulative effects.

6. Interrelated and Interdependent Effects

NMFS is issuing an Incidental Take Permit (ITP) to Tacoma for two distinct types of activities. These are: 1) the withdrawal of water under the First Diversion Water Right Claim (FDWRC), the Second Diversion Water Right (SDWR), and effects of springtime storage of the SDWR on downstream resources; and 2) upper watershed management actions above the Headworks. Water withdrawal and watershed management are interrelated, but they are not interdependent. However, there is an interdependence between some of the springtime storage of water and the exercise of the SDWR, as presented in Section V of this Opinion. Absent a supply of stored water, the SDWR could not be exercised during part of the summer and early fall when stream flow is low and water demand is high. The availability of stored water will increase Tacoma's opportunity to exercise its SDWR.

D. Integration and Synthesis of Effects

Tacoma's water withdrawal from the Green River is expected to cause a mix of adverse and beneficial effects to listed and unlisted fish species. Flow reductions may hinder adult and juvenile upstream and downstream migrations, although the modeled flow analysis indicates that adult chinook passage will be possible in nearly every case. Passage difficulties should be less for adults of other species due to their lesser water depth requirements and or different season of migration, when flows are greater. Juvenile fish will be able to migrate downstream, but there tends to be a positive correlation between juvenile-to-adult survival and volume of stream flow during the spring outmigration months. We estimate that slightly lower survival rates may prevail as a result of the anticipated flow reductions.

Flow reductions are estimated to reduce juvenile side channel rearing habitat but increase mainstem rearing habitat. These reductions would be partially offset through conservation measures that add 3.4 miles of side channel habitat and reconnect some side channels. Flow reductions would also decrease potential chinook spawning habitat, although spawning habitat isn't considered limiting for the species. As one of the conservation measures, Tacoma will supplement the supply of spawning gravel in the Green River downstream of HHD. Any effects on spawning habitat are likely to be offset by gravel supplementation. Overall, there is a low risk of dewatering salmon redds. Flow reduction from water withdrawal may exacerbate steelhead redd dewatering. There may be a slight risk of increased exposure to flood flows that could scour redds and reduce egg or alevin survival.

Water withdrawal occurs at a screened diversion that may impinge or entrain juvenile fish migrating downstream from the upper river basin. The proposed screen will meet NMFS' screen criteria and is expected to successfully pass at least 98% of juvenile fish.

The conservation measures include Tacoma's participation in developing the upstream and downstream passage facilities around HHD. These passage facilities create a significant fisheries opportunity to restore anadromous fish production of chinook, coho, and steelhead to the upper river basin, or nearly 30% of the total potential anadromous fish habitat in the entire basin.

Activities and conservation measures in the Upper Green River watershed will improve water quality and instream habitats for covered species over time. Maintenance and decommissioning of forest roads will substantially decrease delivery of coarse and fine sediments to aquatic systems. Forest management activities are conservative (approximately 40 acres per year harvest) and when combined with riparian management measures provide high assurance of attaining functioning conditions.

We anticipate that the activities covered under the proposed ITP may contribute to, or result in, some degradation of critical habitat and or take listed or unlisted fish. However, such degradation and take is not expected to rise to either the level of destruction or adverse modification of critical habitat nor jeopardize the continued existence of threatened Puget Sound chinook. This determination also applies to covered, currently unlisted, anadromous fish.

E. Conclusion

This ITP will allow Tacoma to provide a consistent water supply to residents while maintaining adequate stream flow for listed fish. While there are uncertainties associated with the activities and their effects, the proposed conservation measures will improve and allow access to significant and substantial habitat that has long been unavailable. The processes for adaptive management provide a mechanism for adjusting future activities based on the results from proposed monitoring and evaluation.

This analysis has examined the covered activities described in the HCP, the jurisdictional fish species that may be affected, the processes by which there may be effects, and the consequences thereof on the overall productivity of salmonids and their habitats across the plan area. NMFS has examined general information in the species' Status Reviews (Table 1.), specific information in the Services' FEIS, the Tacoma Water HCP and finds these and other sources of information to be sufficient with which to conduct this analysis.

After analyzing direct, indirect, cumulative, interrelated, and interdependent effects; and based on the best available scientific information, NMFS concludes that issuance of the proposed ITP is not likely to jeopardize the continued existence of threatened Puget Sound chinook, or the unlisted anadromous fishes that occur in the plan area. Based on the best available scientific information, NMFS concludes that issuance of the proposed ITP will not appreciably reduce the likelihood of survival and recovery of the threatened Puget Sound chinook salmon and is not likely to result in the destruction or adverse modification of their designated critical habitat. NMFS further concludes that issuance of the proposed ITP will not appreciably reduce the likelihood of survival and recovery of currently unlisted, covered species or result in the destruction or adverse modification of critical habitats that may be designated for these species should they be listed under the ESA.

VII. INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. Harm is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR Section 222.102). Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the proposed action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with this Incidental Take Statement.

Take of threatened Puget Sound chinook has been prohibited by a final 4(d) rule that became effective on January 9, 2001 (65 Fed. Reg. 42422, July 10, 2000). The Incidental Take Permit proposed to be issued by the NMFS provides authorization to take listed species under the terms of the HCP, IA, and the Permit itself.

The Tacoma Water HCP and its associated documents clearly identify anticipated impacts to affected species likely to result from the proposed activities and the measures that are necessary and appropriate to minimize those impacts. Tacoma's withdrawal of water from the Green River and North Fork well field may result in the take of chinook and other unlisted salmonids or their critical habitat in the following ways: 1) impingement or entrainment at the headworks diversion screen; 2) reduced flows may adversely affect adult and juvenile upstream and downstream migration; 3) reducing adult spawning habitat area, and 4) by decreasing side-channel juvenile rearing habitat area and accessibility. Covered activities with a high likelihood of causing injury or death to individual anadromous salmonids include sediments introduced to streams from routine watershed management, sediments delivered to streams through catastrophic events such as slope failures that are directly or indirectly related to forest management operations, road construction and repair, and cable- and ground-based movement of logs near and through riparian areas. For example, incubating eggs downstream of road repair sites could be smothered by careless operations where sediment containment is ineffective or the ground-disturbing activities occur during extreme wet conditions. Fish could be dewatered or smothered in tributary streams next to forest road repair. Incubating eggs could be disturbed by incidental or careless movement of cables or logs through riparian yarding corridors, or by modifying vegetation to create the yarding corridors themselves. An example of effects beyond the egg stage might be increased avian or fish predation of rearing juvenile salmon that have been temporarily or chronically displaced by changes in preferred or useable habitats (loss of pool complexity, depth, frequency or distribution) from sediment input and storage. The frequency, location and duration of covered activities resulting in levels of impacts severe enough to harm fish are too speculative to allow NMFS to estimate possible numbers of fish taken under this HCP.

A. Incidental Take of Covered Species

1. <u>Puget Sound Chinook - Listed Species</u>

The NMFS anticipates that an undetermined number of Puget Sound chinook salmon may be taken as a result of full implementation of the proposed action and associated level of protection over the permit term and possible extensions. The incidental take of this species is expected to be in the form of harm, harassment, kill, and injury, resulting from activities covered under the HCP. As analyzed in this opinion, the NMFS has determined that this extent of anticipated take is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

Harm may occur due to habitat modifications resulting from watershed management and and forestry activities in the Upper Green River watershed. Reductions in the amount and quality of habitat may occur in the Middle and Lower Green River as a consequence of water withdrawals and storage. Harm may occur from reduced flows that may adversely affect adult and juvenile upstream and downstream migration; reduce adult spawning habitat area, and decrease side-channel juvenile rearing habitat area and accessibility.

Harassment may occur when instream activities are conducted where fish are present, such as the creation and use of log yarding corridors through riparian zones, road maintenance and improvements, and monitoring activities. Operation and maintenance of the fish passage facilities provide opportunities for human, avian, and mammalian harassment of adult and juvenile life stages during upstream and downstream migrations. Implementation of habitat conservation measures may displace, crowd or otherwise harass juveniles or adults.

Kill may occur due to the use of equipment in streams during construction and maintenance of forest roads, equipment and operational failures at fish passage facilities, and catastrophic inputs of coarse and fine sediments through management-related mass-wasting. Juveniles may be killed through impingement on screens in downstream passage facilities and in the conduct of monitoring activities. Adults may be incidentally killed in the conduct of trap and haul operations to transport fish to the Upper Green River.

Injury may occur with instream activities where fish are present, such as construction and maintenance and improvements of forest roads, equipment and operational failures at fish passage facilities, and the conduct of forest management activities in and near fish-bearing streams. Juveniles may be killed through impingement on screens in downstream passage facilities and in the conduct of monitoring activities. Adults may be injured in the conduct of trap and haul operations to transport fish to the Upper Green River.

2. <u>Puget Sound Coho Salmon - Unlisted Species</u>

The NMFS anticipates that an undetermined number of Puget Sound coho salmon may be taken as a result of full implementation of the proposed action and associated level of protection over the permit term and possible extensions. The incidental take of this species is expected to be in the form of harm, harassment, kill, and injury, resulting from activities covered under the HCP. As analyzed in this opinion, the NMFS has determined that this extent of anticipated take is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

Harm may occur due to habitat modifications resulting from watershed management and forestry activities in the Upper Green River watershed. Reductions in the amount and quality of habitat may occur in the Middle and Lower Green River as a consequence of water withdrawals and storage. Harm may occur from reduced flows that may adversely affect adult and juvenile upstream and downstream migration; reduce adult spawning habitat area, and decrease side-channel juvenile rearing habitat area and accessibility.

Harassment may occur when instream activities are conducted where fish are present, such as the creation and use of log yarding corridors through riparian zones, road maintenance and improvements, and monitoring activities. Operation and maintenance of the fish passage facilities provide opportunities for human, avian, and mammalian harassment of adult and juvenile life stages during upstream and downstream migrations. Implementation of habitat conservation measures may displace, crowd or otherwise harass juveniles or adults.

Kill may occur due to the use of equipment in streams during construction and maintenance of forest roads, equipment and operational failures at fish passage facilities, and catastrophic inputs of coarse and fine sediments through management-related mass-wasting. Juveniles may be killed through impingement on screens in downstream passage facilities and in the conduct of monitoring activities. Adults may be killed in the conduct of trap and haul operations to transport fish to the Upper Green River.

Injury may occur with instream activities where fish are present, such as construction and maintenance and improvements of forest roads, equipment and operational failures at fish passage facilities, and the conduct of forest management activities in and near fish-bearing streams. Juveniles may be killed through impingement on screens in downstream passage facilities and in the conduct of monitoring activities. Adults may be injured in the conduct of trap and haul operations to transport fish to the Upper Green River.

3. <u>Puget Sound / Strait of Georgia Chum Salmon - Unlisted Species</u>

The NMFS anticipates that an undetermined number of Puget Sound / Strait of Georgia chum salmon may be taken as a result of full implementation of the proposed action and associated level of protection over the permit term and possible extensions. The incidental take of this species is expected to be in the form of harm, harassment, kill, and injury, resulting from activities covered under the HCP. As analyzed in this opinion, the NMFS has determined that this extent of anticipated take is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

Harm may occur with reductions in the amount and quality of habitat in the Middle and Lower Green River as a consequence of water withdrawals and storage.

Harassment may occur with the operation and maintenance of the fish passage facilities that provide opportunities for human, avian, and mammalian harassment of adults. Implementation of habitat conservation measures may displace, crowd or otherwise harass juveniles or adults.

Kill may occur with use of equipment in streams during construction and maintenance of facility roads and site developments, equipment and operational failures at fish passage facilities, and catastrophic inputs of coarse and fine sediments through management-related mass-wasting. Adults may be injured in the conduct of monitoring activities. Adults also may be injured in the unlikely event they enter upstream fish passage facilities or are present during trap and haul operations to transport other fish species to the Upper Green River.

Injury may occur with instream activities where fish are present, such as construction and maintenance of facility roads and site developments, and through equipment and operational failures at fish passage facilities. Adults may be injured in the conduct of monitoring activities. Adults also may be injured in the unlikely event they enter upstream fish passage facilities or are present during trap and haul operations to transport other fish species to the Upper Green River.

4. Pink Salmon - Odd-year ESU - Unlisted Species

The NMFS anticipates that an undetermined number of pink salmon may be taken as a result of full implementation of the proposed action and associated level of protection over the permit term and possible extensions. The incidental take of this species is expected to be in the form of harm, harassment, kill, and injury, resulting from activities covered under the HCP. As analyzed in this opinion, the NMFS has determined that this extent of anticipated take is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

Harm may occur with reductions in the amount and quality of habitat in the Middle and Lower Green River as a consequence of water withdrawals and storage.

Harassment may occur with the operation and maintenance of the fish passage facilities that provide opportunities for human, avian, and mammalian harassment of adults. Implementation of habitat conservation measures may displace, crowd or otherwise harass juveniles or adults.

Kill may occur with use of equipment in streams during construction and maintenance of facility roads and site developments, equipment and operational failures at fish passage facilities, and catastrophic inputs of coarse and fine sediments through management-related mass-wasting. Adults may be injured in the conduct of monitoring activities. Adults also may be injured in the unlikely event they enter upstream fish passage facilities or are present during trap and haul operations to transport other fish species to the Upper Green River.

Injury may occur with instream activities where fish are present, such as construction and maintenance of facility roads and site developments, and through equipment and operational failures at fish passage facilities. Adults may be injured in the conduct of monitoring activities. Adults also may be injured in the unlikely event they enter upstream fish passage facilities or are present during trap and haul operations to transport other fish species to the Upper Green River.

5. Sockeye Salmon (unassigned ESU) - Unlisted Species

The NMFS anticipates that an undetermined number of sockeye salmon may be taken as a result of full implementation of the proposed action and associated level of protection over the permit term and possible extensions. The incidental take of this species is expected to be in the form of harm, harassment, kill, and injury, resulting from activities covered under the HCP. As analyzed in this opinion, the NMFS has determined that this extent of anticipated take is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

Harm may occur with reductions in the amount and quality of habitat in the Middle and Lower Green River as a consequence of water withdrawals and storage.

Harassment may occur with the operation and maintenance of the fish passage facilities that provide opportunities for human, avian, and mammalian harassment of adults. Implementation of habitat conservation measures may displace, crowd or otherwise harass juveniles or adults.

Kill may occur with use of equipment in streams during construction and maintenance of facility roads and site developments, equipment and operational failures at fish passage facilities, and catastrophic inputs of coarse and fine sediments through management-related mass-wasting. Adults may be injured in the conduct of monitoring activities. Adults also may be injured in the unlikely event they enter upstream fish passage facilities or are present during trap and haul operations to transport other fish species to the Upper Green River.

Injury may occur with instream activities where fish are present, such as construction and maintenance of facility roads and site developments, and through equipment and operational failures at fish passage facilities. Adults may be injured in the conduct of monitoring activities. Adults also may be injured in the unlikely event they enter upstream fish passage facilities or are present during trap and haul operations to transport other fish species to the Upper Green River.

6. Puget Sound Steelhead - Unlisted Species

The NMFS anticipates that an undetermined number of Puget Sound steelhead may be taken as a result of full implementation of the proposed action and associated level of protection over the permit term and possible extensions. The incidental take of this species is expected to be in the form of harm, harassment, kill, and injury, resulting from activities covered under the HCP. As analyzed in this opinion, the NMFS has determined that this extent of anticipated take is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

Harm may occur due to habitat modifications resulting from watershed management and and forestry activities in the Upper Green River watershed. Reductions in the amount and quality of habitat may occur in the Middle and Lower Green River as a consequence of water withdrawals and storage. Harm may occur from reduced flows that may adversely affect adult and juvenile upstream and downstream migration and decrease side-channel juvenile rearing habitat area and accessibility.

Harassment may occur when instream activities are conducted where fish are present, such as the creation and use of log yarding corridors through riparian zones, road maintenance and improvements, and monitoring activities. Operation and maintenance of the fish passage facilities provide opportunities for human, avian, and mammalian harassment of adult and juvenile life stages during upstream and downstream migrations. Implementation of habitat conservation measures may displace, crowd or otherwise harass juveniles or adults.

Kill may occur due to the use of equipment in streams during construction and maintenance of forest roads, equipment and operational failures at fish passage facilities, and catastrophic inputs of coarse and fine sediments through management-related mass-wasting. Eggs and alevins may be killed in the Middle and Lower Green River when water is allocated to provide flows in deference to threatened Puget Sound chinook salmon. Juveniles may be killed through impingement on screens in downstream passage facilities and in the conduct of monitoring activities. Adults may be incidentally killed in the conduct of trap and haul operations to transport fish to the Upper Green River.

Injury may occur with instream activities where fish are present, such as construction and maintenance and improvements of forest roads, equipment and operational failures at fish passage facilities, and the conduct of forest management activities in and near fish-bearing streams. Juveniles may be killed through impingement on screens in downstream passage facilities and in the conduct of monitoring activities. Adults may be injured in the conduct of trap and haul operations to transport fish to the Upper Green River.

B. Reasonable and Prudent Measures

All conservation measures described in the final HCP (Tacoma 2001), together with the terms and conditions described in the associated Implementation Agreement and the section

10(a)(1)(B) permit issued with respect to the HCP, are hereby incorporated by reference as reasonable and prudent measures and terms and conditions imposed on Tacoma within this Incidental Take Statement. Such terms and conditions are non-discretionary and must be undertaken for the exemptions under section 10(a)(1)(B) and section 7(o)(2) of the ESA to apply. If NMFS becomes aware that the permittee is not implementing the HCP in good faith and fails to adhere to the terms and conditions, NMFS shall revoke the permit. The amount or extent of incidental take anticipated under the proposed HCP, associated reporting requirements, and provisions for disposition of dead or injured animals are as described in the HCP and its accompanying section 10(a)(1)(B) permit.

If future information indicates that provisions of the HCP are incompatible with the survival and recovery of the listed species, NMFS shall use the relevant clauses of the IA to reopen the HCP/ITP and modify those provisions. To reduce risks to listed salmon, NMFS shall actively review and assess the results of the monitoring and evaluations elements of the HCP.

VIII. REINITIATION OF CONSULTATION

This concludes formal consultation on these actions in accordance with 50 CFR 402.14(b)(1). Reinitiation of consultation is required: (1) If the action is modified in a way that causes an effect on the listed species that was not previously considered in the biological assessment and this biological opinion; (2) new information or project monitoring reveals effects of the action that may affect the listed species in a way not previously considered; or (3) a new species is listed or critical habitat is designated that may be affected by the action (50 CFR 402.16).

IX. SECTION 10 (a)(2)(B) FINDINGS

A. Permit Issuance Considerations

Although only one of the six anadromous salmonid species addressed in the HCP are listed under the ESA at this time, this document is intended to provide Tacoma Water assurances that they will receive an Incidental Take Permit if and when such unlisted species are subsequently listed under the ESA, subject to the "unforeseen circumstances" clause in the IA. In order to issue an incidental take permit under the ESA Section 10(a)(1)(b) and 50 C.F.R. § 222.307 (FR, Vol. 64, No. 55, March 23, 1999)NMFS must consider the following:

1. The status of the affected species or stocks. The status of anadromous salmonids potentially affected by the HCP has been considered above (Section III). Green River chinook are described as among the healthier Puget Sound chinook populations, although depressed runs have occurred in some of the recent seasons. The environmental baseline for anadromous fish and their habitats (Section IV) was also considered. The Green River basin is quite heavily developed, and its suitability for salmonid production downstream from the Headworks dam is significantly compromised. Some of the most productive potential habitat is upstream from Howard Hanson Dam.

2. The potential severity of direct, indirect and cumulative impacts on anadromous salmonids and their habitats as a result of the proposed activity. The impacts of the HCP were examined in detail in this analysis (Section VI). Slight to minor adverse effects are expected to accrue from water withdrawal and upper watershed management activities. However, moderate to significantly beneficial effects are predicted to accrue from the proposed conservation measures and upper watershed management activities over time.

3. The availability of effective monitoring techniques. Monitoring of the implementation of the HCP and the effectiveness of the HCP prescriptions are a critical feature of this HCP. Monitoring reports will be completed and submitted to NMFS and the USFWS according to the schedule described in Section VIII of the HCP. The frequency and period of monitoring varies by plan element with compliance monitoring of key items extending throughout the entire 50-year term of the plan.

4. The use of the best available technology for minimizing and mitigating impacts. The prescriptions established in this HCP represent the most recent developments in science and technology in minimizing and mitigating impacts to riparian and aquatic habitats, from road management to silvicultural treatment of riparian forests to preserve and enhance ecological functions. Further, the adaptive management component of this HCP assures new science and technology will continue to be employed in the HCP as it is developed.

5. The views of the public, scientists and other interested parties knowledgeable of the species or stocks or other matters related to the application. Over the past few years, the Applicant has

hosted many tours of the Plan Area, meetings with stakeholders, and kept interested citizens informed through public meetings related to the HCP.

Tacoma first submitted a preliminary working draft to the Services in September 1998. In November of 1998, Tacoma submitted the first working draft of the HCP to the Services, as well as, the US Environmental Protection Agency, US Army Corps of Engineers, Muckleshoot Indian Tribe and several Washington State resource agencies. In addition, copies of this draft were placed in six public libraries for citizen review and comment. A second working draft of the HCP was submitted to the Services in July of 1999. This draft was also mailed to other federal, state, and local governmental agencies, and the Muckleshoot Indian Tribe for review and comment prior to the development of the final draft HCP.

During the development of this draft the Services worked with Tacoma to develop an Environmental Impact Statement (EIS) and Implementing Agreement (IA) to accompany the HCP. The Services formally initiated an environmental review of the project through a Federal Register notice on August 21, 1998 (63 FR 44918). This notice stated that an Environmental Assessment (EA) or an EIS would be prepared. The notice also announced a 30-day public scoping period during which other agencies, tribes, and the public were invited to provide comments and suggestions regarding issues and alternatives to be considered. A second Federal Register notice was published following the scoping period on January 20, 1999 (64 Fed. Reg. 3066), announcing the decision to prepare an Environmental Impact Statement. Tacoma submitted final draft documents of the HCP, EIS, and IA with their formal application for an incidental take permit on December 23, 1999. On January 14, 2000, the Services initiated a 60-day public comment period under the National Environmental Policy Act of 1969, as amended (NEPA)(63 Fed. Reg. 68469). The comment period was extended for 17 days to March 31, 2000 (65 Fed. Reg. 13947), in direct response to requests from the public. This resulted in a total comment period of 77 days.

A total of 73 comment letters were received by the Services pertaining to the DEIS and HCP: 10 from government agencies, 2 from tribal representative organizations, 11 from public organizations, and 50 from individual citizens. Volume II of the FEIS contains copies of all of those letters and the Services' responses. Many of the comments and suggestions were incorporated into the HCP and FEIS. A summary of changes made to the HCP and EIS is included the Preface section of the FEIS.

The Final Environmental Impact Statement was noticed in the Federal Register on January 5, 2001 (66 FR 1089). Two public interest groups and one individual submitted comment letters regarding the FEIS. Summaries and responses to comments are contained in Appendix B of the Services Record of Decision (July 2001, on file at NMFS WSHB office, Lacey, WA).

The public process had substantial influence on the final outcome of this proposal. A number of substantive changes were made in the proposed HCP and DEIS as a direct result of public comments. These changes were incorporated into the final HCP and EIS. Another factor the Services considered in making the decision was consistency with the Federal Trust responsibility to Native American Tribes. This Trust responsibility imposes a duty on Federal agencies to protect Trust assets for Tribes. Through the development and comment phases of drafts of the HCP, the Services have held numerous meetings with affected tribal governments or their technical staffs to inform, discuss, and represent their interests in these matters. The Services have concluded that the proposed HCP is consistent with this Trust responsibility.

B. Permit Issuance Findings

Having considered the above, the NMFS makes the following findings under Section 10(a)(2)(b) of the ESA with regard to the adequacy of the HCP meeting the statutory and regulatory requirements for an Incidental Take Permit under Section 10(a)(1)(B) of the ESA and 50 C.F.R. § 222.307:

1. The taking of listed species will be incidental. The NMFS anticipates that the proposed action would likely result in incidental take of threatened Puget Sound chinook and other currently unlisted species of anadromous salmonids. Activities that will occur in the HCP area that may result in take may include "harm" through adverse changes in essential habitat features such as elevated wood loading or short-term passage limitations in the channel from premature blow-down of managed riparian forests, inadvertent damage to channels or streambanks from log removal or tree felling, and additional sediment inputs due to landslides and road use throughout the planning area. Also, take may occur via the "harass, kill, or injury" definition as well, by frightening or disturbing spawning fish during road construction or crossings or monitoring and research activities. Some instances of incidental take will likely occur despite the conservation measures in the HCP. These types of take are speculative, not quantifiable, and would be limited in extent to a fraction of the action area. Juvenile fish may be impinged on or entrained through the diversion screen. Adult and juvenile migration and juvenile rearing in side channels may be affected or reduced as a result of water withdrawal. While such taking will likely occur, it will happen unintentionally and in the course of otherwise legal activities.

2. Tacoma Water will, to the maximum extent practicable, minimize and mitigate the impacts of taking anadromous salmonids associated with watershed management and related activities. Three water withdrawal and upper watershed management alternatives were analyzed in the EIS. Other alternatives were identified and not analyzed because they would not accomplish Tacoma's objective of meeting current and future water demands or protect water quality. Another alternative involving the Forest and Fish Report was identified but not analyzed because the conservation measures of the proposed HCP surpasses those in the Forest and Fish report. The HCP includes conservation measures to supplement spawning gravel, increase side channel habitat, and provide upstream and downstream passage at HHD and the Headworks. Measures in this HCP minimize and mitigate for any take that may occur, through assurance of timely remediation of road drainage, design, and sediment effects; identification of unstable slopes and avoidance of harvest thereon; by the retention and management of riparian forests throughout the HCP area that assure attainment of properly functioning riparian habitats for fish-bearing streams during the plan term; and by installation and operation of diversion screening that meets NMFS'

criteria. Also, Tacoma Water will monitor and conduct research to test assumptions and to determine effectiveness of HCP prescriptions.

3. Based upon the best available scientific information, the taking will not appreciably reduce the likelihood of the survival and recovery of the species in the wild, or adversely modify or destroy critical habitat for Puget Sound chinook. Conservation measures identified in the plan will increase the quality and quantity of spawning and rearing habitat and result in a benefit to anadromous salmonid species. The Act's legislative history establishes the intent of Congress that this issuance criteria be based on a finding of "not likely to jeopardize" under section 7(a)(2) [see 50 C.F.R.§402.02]. This is the identical standard to Section 10(a)(2)(B). The conclusions regarding jeopardy for the listed ESU and for all other unlisted anadromous salmonid are found in Section VI.. In summary, the NMFS has considered the status of the species, the environmental baseline and the effects of the proposed action, and any indirect and cumulative effects, to conclude that issuance of the Incidental Take Permit for Puget Sound chinook salmon to the City of Tacoma for anadromous fish species, would likely not jeopardize the continued existence of any of the anadromous salmonids addressed in the HCP.

4. The Tacoma HCP has been developed to assure that other measures, as required by the NMFS have been met. The HCP and IA incorporate all elements determined by the NMFS to be necessary for approval of the HCP and issuance of the permit.

5. The NMFS has received the necessary assurance that the plan will be funded and implemented. The suite of mitigation, minimization, and adaptive management measures have assured funding commensurate with the effort and operational costs specific to each element. Signing of the IA by the City of Tacoma assures that the HCP will be implemented. Also, the HCP and IA commit the City of Tacoma to adequately fund implementation of the HCP.

C. Conclusion

Based on these findings, it is determined that the Applicant’s HCP meets the statutory and regulatory requirements for an Incidental Take Permit under Section 10(a)(1)(B) of the ESA and 50 C.F.R. § 222.307.

IX. ESSENTIAL FISH HABITAT CONSULTATION

A. Background

The Magnuson-Stevens Fishery Conservation and Management Act (MSA), as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267), established procedures designed to identify, conserve, and enhance Essential Fish Habitat (EFH) for those species regulated under a Federal fisheries management plan. Pursuant to the MSA:

- Federal agencies must consult with NMFS on all actions, or proposed actions, authorized, funded, or undertaken by the agency, that may adversely affect EFH (§305(b)(2));
- NMFS shall provide conservation recommendations for any Federal or State activity that may adversely affect EFH (§305(b)(4)(A));
- Federal agencies shall within 30 days after receiving conservation recommendations from NMFS provide a detailed response in writing to NMFS regarding the conservation recommendations. The response shall include a description of measures proposed by the agency for avoiding, mitigating, or offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with the conservation recommendations of NMFS, the Federal agency shall explain its reasons for not following the recommendations (§305(b)(4)(B)).

EFH means those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity (MSA §3). For the purpose of interpreting this definition of EFH: Waters include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; substrate includes sediment, hard bottom, structures underlying the waters, and associated biological communities; necessary means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers a species' full life cycle (50 CFR 600.110). Adverse effect means any impact which reduces quality and/or quantity of EFH, and may include direct (*e.g.*, contamination or physical disruption), indirect (*e.g.*, loss of prey or reduction in species fecundity), site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810).

Any reasonable attempt to encourage the conservation of EFH must take into account actions that occur outside EFH, such as upstream and upslope activities, that may have an adverse effect on EFH. Therefore, EFH consultation with NMFS is required by Federal agencies regarding any activity that may adversely affect EFH, regardless of its location.

The objective of this EFH consultation is to determine whether the proposed action may adversely affect designated EFH, and to recommend conservation measures to avoid, minimize, or otherwise offset potential adverse impacts to EFH resulting from the proposed action.

B. Identification of Essential Fish Habitat

Pursuant to the MSA the Pacific Fisheries Management Council (PFMC) has designated EFH for three species of federally-managed Pacific salmon: chinook (*Oncorhynchus tshawytscha*); coho (*O. kisutch*); and Puget Sound pink salmon (*O. gorbuscha*)(PFMC 1999). Freshwater EFH for Pacific salmon includes all those streams, lakes, ponds, wetlands, and other water bodies currently, or historically accessible to salmon in Washington, Oregon, Idaho, and California, except areas upstream of certain impassable man-made barriers (as identified by the PFMC), and longstanding, naturally-impassable barriers (i.e., natural waterfalls in existence for several hundred years). Detailed descriptions and identifications of EFH for salmon are found in Appendix A to Amendment 14 to the Pacific Coast Salmon Plan (PFMC 1999). Assessment of the impacts to these species' EFH from the proposed action is based, in part, on this information.

C. Proposed Actions

The proposed action and action area are detailed above in Section II of this Opinion as the issuance of an Incidental Take Permit (ITP) under Section 10 of the ESA for the implementation of a habitat conservation plan (HCP) and its associated Implementing Agreement by the Tacoma Water, an agency of the City of Tacoma, Washington. The action area includes habitats that have been designated as EFH for various life-history stages of chinook, coho and Puget Sound pink salmon.

D. Effects of the Proposed Actions

As analyzed above in Section VI, these activities may result in detrimental short- and long-term impacts to a variety of habitat parameters. The Tacoma Water HCP and its associated documents clearly identify anticipated impacts to affected species likely to result from the proposed activities and the measures that are necessary and appropriate to minimize those impacts. These effects include delivery of sediments to streams through routine watershed management and through catastrophic events such as slope failures that are directly or indirectly related to forest management operations, road construction and repair, and cable- and ground-based movement of logs near and through riparian areas.

E. Conclusion

The NMFS believes that the proposed action may adversely affect designated EFH for chinook, coho, and Puget Sound pink salmon.

F. EFH Conservation Recommendations

The conservation measures Tacoma included in the HCP as part of the proposed activities are adequate to minimize the adverse impacts from these activities to designated EFH for Pacific salmon. NMFS understands that Tacoma intends to implement these conservation measures to minimize potential adverse effects to the maximum extent practicable. Consequently, NMFS has no additional conservation recommendations to make at this time.

G. Statutory Response Requirement

Please note that the Magnuson-Stevens Act and 50 CFR § 600.920(j) require the Federal agency to provide a written response to NMFS' EFH conservation recommendations within 30 days of its receipt of this letter. However, since NMFS did not provide conservation recommendations for this action, a written response to this consultation is not necessary.

H. Supplemental Consultation

The NMFS must reinitiate EFH consultation if the actions described in this consultation are substantially revised or new information becomes available that affects the basis for NMFS' EFH conservation recommendations (50 CFR § 600.920(k)).

X. REFERENCES

Section 7(a)(2) of the ESA requires biological opinions to be based on the best scientific and commercial data available. This section identifies the data and references used in developing this Opinion.

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